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PHILIPPINE PINE-NEEDLE OIL FROM PINUS INSULARIS (ENDLICHER)

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TWO PLATES

Benguet pine (*Pinus insularis* Endlicher) forms extensive forests in the mountain regions of northern Luzon. Some months ago we investigated samples of resin tapped from the Benguet pine and our results showed that a turpentine [1] of good quality and a high-grade rosin [2] are obtained from it. Recently we investigated the oil obtained from the leaves (needles) of Benguet pine and found that the yield of oil is very small. The oil appears to consist largely of alpha- and beta-pinene and to contain only a small percentage of esters calculated as bornyl acetate.

Leaf oils are obtained from the leaves of numerous kinds of trees. Oil distilled from the leaves of pine trees is known as pine-needle oil and a number of these oils obtained from dif-

[1] Santos, I. de, A. P. West, and J. Fontanoza, Philip. Journ. Sci. 45 (1931) 233.

[2] Santos, I. de, A. P. West, and J. Fontanoza, loc. cit.

ferent species of pine have been investigated. In general, these oils consist essentially of a mixture of terpenes.

Pine-needle oil has a fragrant odor and is useful in compounding perfumes. It has also been employed as a repellent for certain insects [3] and as a larvicide for mosquitoes.[4]

EXPERIMENTAL PROCEDURE

Through the kindness of Mr. Sixto Laraya, of the Philippine Bureau of Forestry, our laboratory has been supplied during recent months with occasional shipments of pine-needles and twigs. These were gathered from pine trees growing in and near Baguio, a summer resort situated at an elevation of about 1,500 meters in Mountain Province, Luzon.

The pine-needles and twigs were placed in a large apparatus and steam distilled. The pine-needle oil thus obtained was separated from the aqueous distillate and dehydrated with calcium chloride. The yield of oil distilled from leaves and twigs was only 0.043 per cent and subsequent experiments showed that most of the yield was obtained from the leaves and not from the leafless twigs. The oil was slightly greenish yellow in color and had a strong aromatic odor. The constants of the oil were determined and the data are recorded in Table 1.

TABLE 1.—*Constants of pine-needle oil.*

Specific gravity $\left(\frac{30^\circ C}{4^\circ}\right)$	0.8582
Optical rotation $\left(A \frac{30^\circ}{D}\right)$, degrees	+20.53
Refractive index $\left(n \frac{30^\circ}{D}\right)$	1.4700
Acid value	1.38
Saponification value	7.67
Ester value (7.67 − 1.38)	6.29
Esters as bornyl acetate, per cent	1.75

Benguet pine-needle oil was found to be soluble in 10 parts of alcohol (90 per cent). When distilled (fractionated) we obtained the results recorded in Table 2. The first three fractions were practically colorless while the residue had a red color.

[3] Bishop, F. C., R. C. Roark, D. C. Parman, and E. W. Laake, Journ. Econ. Entomol. 18 (1925) 776.

[4] Barnes, M. E., Am. Journ. Hyg. 5 (1925) 309.

TABLE 2.—*Distillation of Benguet pine-needle oil (Amount of oil distilled, 76 cubic centimeters.)*

Fraction. No.	Fraction. Temperature.	Amount obtained.		Refractive index, $N\frac{30°C}{D}$.	Specific gravity, $d\frac{30°C}{4°C}$.	Optical rotation, $A\frac{30°C}{D}$ (100 mm. tube).
	°*C.*	*Grams.*	*Per cent.*			*Degrees.*
1	Below 155	3.7	4.9	----------	----------	----------
2	155 to 160	34.4	45.3	1.4645	0.8476	+28.7
3	160 to 164	26.7	35.1	1.4677	0.8493	+18.8
4	Residue	10.8	14.2	----------	0.9420	----------

In Table 3 are given the boiling points of a few terpene compounds that commonly occur in pine-needle oils.

TABLE 3.—*Boiling points of a few common terpenes.*

Terpene.	Boiling point, ° C.
Alpha-pinene	156–157
Beta-pinene	164–166
Dipentene	170–172
Limonene	172.6–178.2
Borneol	208–213

A comparison of the data given in Tables 2 and 3 indicates that fraction 2 of Benguet pine-needle oil probably contains alpha-pinene and fraction 3 beta-pinene. A sample of fraction 2 was cooled in ice and treated with dry hydrochloric acid gas. There separated out a heavy thick oil that had a strong odor of pinene hydrochloride (artificial camphor). The presence of other substances seemed to prevent the hydrochloride from crystallizing.

A portion of fraction 3 was oxidized with alkaline permanganate. The reaction product was steam distilled and the residue filtered to eliminate manganese oxide. When the filtrate was evaporated somewhat and cooled, white crystals of sodium nopinate separated out. A portion of these crystals was decomposed with dilute sulphuric acid and extracted with benzene. Needles melting at 125.5° to 127° C. were thus obtained, indicating that fraction No. 3 contains beta-pinene.

Due to the very small yield of oil from Benguet pine leaves we did not have sufficient material to make a very thorough investigation of the composition of Benguet pine-needle oil.

In Table 4 are given the constants of pine-needle oils from various species of pine. The figures for specific gravity, refractive index, and optical rotation are not exactly comparable since they were determined at somewhat different temperatures.

As shown by the data (Table 4) pine-needle oils from different species of pine vary considerably in composition. With the exception of *Pinus insularis* and *P. sylvestris*, these oils listed below give a negative rotation. In general, the yield of pine-needle oils is very small. Only one oil (*Pinus pumilis*) gave a yield of more than 0.5 per cent while the other oils gave considerably less.

TABLE 4.—*Constants of pine-needle oils from different species of pine.*

Species.	Yield	Specific gravity.	Optical rotation.	Refractive index.	Acid value.	Esters as bornyl acetate.
	Per cent.					*Per cent.*
Pinus insularis [a]	0.043	0.8582	+20.53	1.4700	1.38	1.75
Abies sibirica [b]	--------	0.9000	—30.00	1.4700	1.00	29.00
Do	--------	0.9280	—43.00	1.4730	4.00	43.00
Pinus longifolia [b]	--------	0.8740	— 6.15	----------	1.03	5.00
Pinus pumilio [b]	0.250	0.8630	— 5.00	1.4740	--------	3.00
Do	0.750	0.8760	—10.00	1.4800	--------	10.00
Pinus sabiniana [b]	0.078	0.8510	—20.00	1.4670	1.47	2.37
Do	0.102	0.8570	—39.00	1.4671	2.05	3.32
Abies magnifica [b]	--------	0.8665	—16.70	1.4861	0.75	3.47
Pinus contorta [b]	--------	0.8690	—17.84	1.4831	0.90	2.11
Pinus ponderosa [b]	0.040	0.8718	—15.73	1.4789	0.67	1.36
Do	0.126	0.8849	—19.59	1.4838	2.36	2.83
Pinus lambertiana [b]	0.045	0.8676	—11.07	1.4777	0.68	0.74
Do	0.120	0.8738	—16.50	1.4794	2.38	2.07
Pinus halepensis [c]	0.260	0.8960	—49.44	1.4940	--------	6.58
Picea vulgaris [d]	--------	0.8800	—21.70	----------	--------	2.90
Do	--------	0.8880	—37.00	----------	--------	3.43
Pinus sylvestris [e]	--------	0.8661	+13.20	1.4729	0.28	----------
Pinus excelsa [f]	0.310	0.8672	—13.76	1.4727	1.00	3.75

[a] *Pinus insularis* from the Philippines.
[b] Parry, E. J., Chemistry Essential Oils and Perfumes 1 (1918) 51.
[c] Rutovskii, B. N., Perfum. Essen. Oils. Rec. 19 (1928) 391.
[d] Allen's Commercial Organic Analysis 4 (1925) 112.
[e] Rao, B. S., and J. L. Simonsen, Journ. Chem. Soc. 127 (1925) 2494.
[f] Rutovskii, B., I. Vinogradova, and V. Koslov., Arbeiten Chem. Pharm. Inst. Moskaus, Lief 11 (1925) 93.

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The authors also wish to thank Mr. Sixto Laraya, of the Philippine Bureau of Forestry, for his kindness in procuring samples of Benguet pine needles for this investigation.

SUMMARY

We have investigated the pine-needle oil obtained from Benguet pine (*Pinus insularis* Endl.).

Benguet pine-needle oil has a positive optical rotation and in this respect is unlike most pine-needle oils which have a negative rotation.

Compared to other pine-needle oils, the yield from Benguet pine leaves is very small (0.043 per cent).

Benguet pine-needle oil appears to consist largely of alpha- and beta-pinene and to contain only a small percentage of esters calculated as bornyl acetate. It is soluble in ten parts of 90 per cent alcohol.

ILLUSTRATIONS

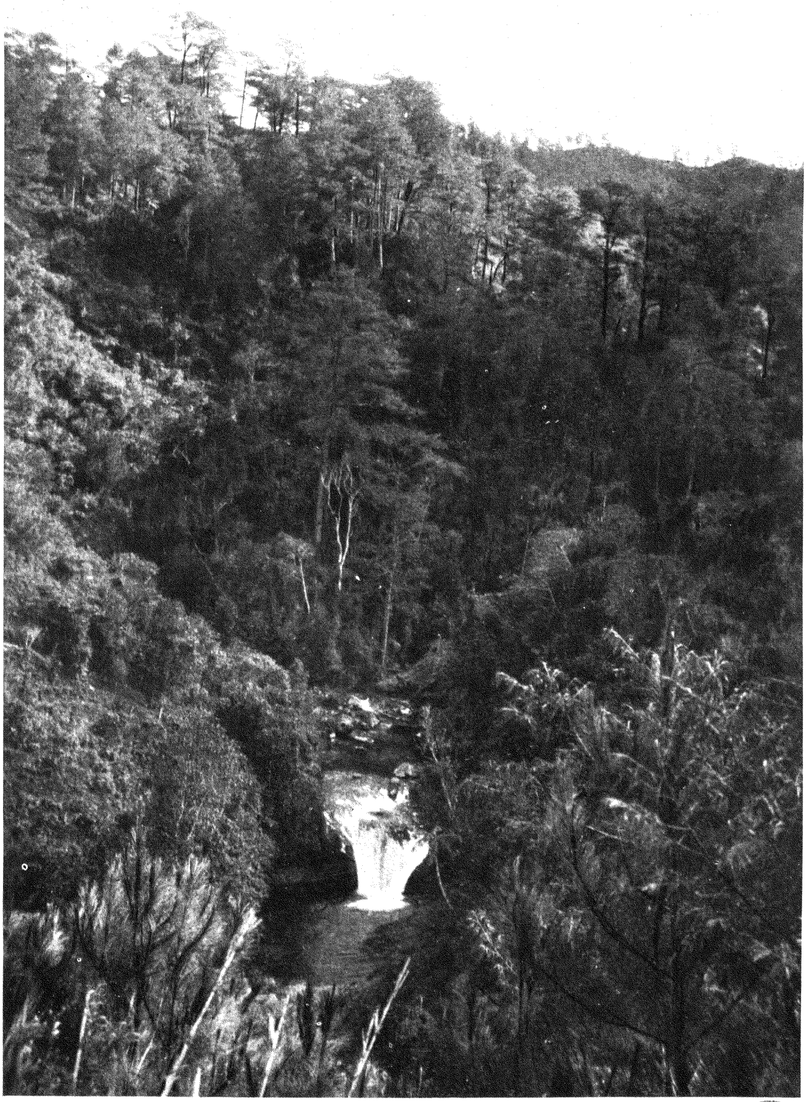

PLATE 1.

PLATE 2.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), X[1]

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THREE PLATES

The important series of Philippine crane flies discussed at this time were collected in Luzon by Messrs. McGregor, Duyag, and Rivera, and in Mindanao by Mr. Charles F. Clagg. I wish to thank the above-mentioned gentlemen for their continued interest in making known the tremendously rich tipulid fauna of the Philippines. All types are preserved in my collection.

TIPULINÆ

SCAMBONEURA NIGROTERGATA sp. nov. Plate 2, fig. 23.

General coloration obscure yellow; antennæ (male) elongate, the scapal segments yellow; mesonotal præscutum with three narrow, ill-delimited, reddish brown lines; postnotal mediotergite and pleura yellow, unmarked; wings subhyaline; anterior arculus bowed; abdominal tergites with a continuous black dorsomedian stripe from base to apex; sternites light yellow; male hypopygium with the tergite uniformly blackened; appendage of ninth sternite small, bilobed.

Male.—Length, about 13 millimeters; wing, 11.3; antenna, about 7.

Frontal prolongation of head obscure yellow; nasus black; palpi light brown, the outer segment passing into black. Antennæ (male) elongate, as shown by the measurements; scape obscure yellow; flagellum black, the segments elongate, their longest verticils about one-fourth to one-fifth the segment. Head obscure orange, with a brown median line on vertex; additional narrower and less-defined dark lines on vertex, delimiting the posterior vertex.

Pronotum obscure yellow. Mesonotal præscutum obscure yellow, with three narrow reddish brown stripes that are ill-de-

[1] Contribution from the entomological laboratory, Massachusetts Agricultural College.

limited; scutum yellowish testaceous, the cephalic half of the lobes blackened; scutellum testaceous; postnotal mediotergite yellow, unmarked. Pleura yellow. Halteres brownish black, the knobs black. Legs with the coxæ and trochanters yellow; femora brownish black, their bases broadly yellow; tibiæ and tarsi black. Wings subhyaline, iridescent, the stigmal region dark brown; veins black. Venation: Anterior cord strongly bowed; m-cu nearly half its length beyond the fork of M.

Abdomen with the tergites pale, with a continuous dull black median stripe the entire length, more extensive and somewhat paler on outer segments; a narrower continuous lateral black line; sternites clear light yellow; hypopygium yellow, the tergite entirely black. Male hypopygium (Plate 2, fig. 23) with the tergite, 9*t*, bearing two conspicuous earlike lobes, separated by a V-shaped median notch that further bears a tiny median tongue-like projection; mesal margin of lobes with delicate setulæ at apex, these replaced by coarse black setæ that merge gradually into short black spines on the face of the lobes. Outer dististyle, *od*, obliquely broadest beyond base, the outline irregular, the outer edge most protuberant just beyond base, the inner margin more strongly rounded at near midlength. Appendage of ninth sternite, 9*s*, small, conspicuously bilobed, the entire surface setiferous.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, July 5, 1930 (*Clagg*); holotype, male.

This species and the next are very different from the other known species of *Scamboneura*, although closely allied to one another. The nearest ally in Luzon would seem to be *S. vittivertex* Alexander.

SCAMBONEURA CALIANENSIS sp. nov. Plate 2, figs. 24 and 25.

Male.—Length, about 15 millimeters; wing, 14.2; antenna, about 6.

Generally similar to *S. nigrotergata* sp. nov.; in the general coloration, differing as follows:

Size larger, but the antennæ (male) proportionately and actually shorter, as shown by the measurements, the flagellar segments being conspicuously shorter. Scutal lobes with the markings reddish brown and occupying the whole lobe. Pleura yellow, vaguely marked with more reddish yellow on the anepisternum and ventral sternopleurite. Abdomen with the dorsomedian black stripe not quite continuous, being narrowly

interrupted at the caudal margins of the segments. Male hypopygium with the tergite (Plate 2, fig. 24, 9*t*) entirely blackened and shaped generally as in *nigrotergata* but the details quite different. Lateral ears conspicuous, with abundant long coarse setæ but no replacement spines on disk; median projection large and conspicuous. Outer dististyle (Plate 2, fig. 25) long and conspicuous, the apex produced into a slender point.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, July 4, 1930 (*Clagg*); holotype, male.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) CANDIDELLA sp. nov. Plate 1, fig. 1; Plate 2, fig. 26.

General coloration yellow, the præscutum with a brown median stripe; antennæ black, the flagellar segments cordate, with glabrous apical necks; legs black, all tarsi with intermediate portions white; wings with a strong blackish suffusion; male hypopygium with the basistyles elongate, the ventromesal lobe small, at extreme base.

Male.—Length, about 6 millimeters; wing, 6.8.

Rostrum and palpi black. Antennæ black throughout; intermediate flagellar segments cordate, with glabrous apical necks that are about one-third the length of the segment; outer segments more elongate; terminal segment long, about one-half longer than the penultimate; verticils shorter than the segments. Head black, the front silvery; anterior vertex relatively wide.

Pronotum dark medially, obscure yellow on sides. Mesonotal præscutum clear yellow, with a narrow median brown stripe, the usual lateral stripes ill-delimited, brownish yellow, the humeral region brightest; scutum yellow, the centers of the lobes vaguely darker; scutellum brown, obscurely brightened posteriorly; postnotum brownish yellow. Pleura light yellow, the dorsal sclerites a little more darkened. Halteres black. Legs with the coxæ and trochanters pale yellow, the fore coxæ a trifle more darkened; femora brownish black, the bases restrictedly brightened; tibiæ dark brown; tarsi dark brown, the intermediate portion of all tarsi snowy white, this involving the distal third or more of basitarsi, the entire second segment and all but the tip of the third segment; the amount of white greatest on the hind legs where the distal two-thirds of the basitarsus is included; claws small, with a single basal tooth. Wings (Plate 1, fig. 1) with a strong black suffusion, the small oval stigma

darker; extreme wing tip vaguely darkened; veins brownish black. Costal fringe of moderate length. Venation: Sc long, Sc_1 ending beyond the fork of Rs, Sc_2 a short distance from its tip; free tip of Sc_2 and R_2 in alignment; Rs less than twice the basal section of R_{4+5}; cell 1st M_2 closed, shorter than any of the veins beyond it; m-cu just beyond the fork of M; vein 2d A long, converging strongly toward 1st A.

Abdominal tergites black; basal sternites obscure yellow; outer sternites and hypopygium darker. Male hypopygium (Plate 2, fig. 26) much as in *L. multinodulosa* in the median extension of the tergite, elongate basistyles, *b*, with the ventromesal lobe small and situated at the extreme base, and the general conformation of the dististyles and gonapophyses. The dorsal dististyle, *dd*, is a more strongly curved hook.

LUZON, Laguna Province, above Ube, foot of Mount Banahao, altitude about 700 meters, on mossy cliff near river in cool forest, February 9, 1930 (*McGregor*); holotype, male.

Limonia (*Limonia*) *candidella* is most closely allied to *L.* (*L.*) *multinodulosa* Alexander (Luzon), differing in the much shorter antennæ of the male and the white intermediate tarsal segments of all the legs. The increased length of the antennæ in *multinodulosa* is produced by the longer glabrous apical necks of the segments.

LIMONIA (LIMONIA) LATIFLAVA sp. nov. Plate 1, fig. 2.

General coloration brownish yellow, the posterior sclerites of the mesonotum blackened; antennæ black; pleura yellow with a black longitudinal stripe; halteres black; legs black, the tarsi and broad tibial tips yellowish white; wings with a blackish tinge, the basal cells streaked with whitish; Sc long, Sc_2 at tip of Sc_1.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum black, relatively long and conspicuous, about one-half as long as the remainder of head; palpi black. Antennæ black throughout; flagellar segments oval. Head black, sparsely pruinose; anterior vertex narrow, lighter gray.

Pronotum black. Mesonotal præscutum obscure brownish yellow, paler laterally, more brownish medially; posterior sclerites of mesonotum more uniformly brownish black. Pleura with a conspicuous longitudinal black stripe extending from the pronotum to the abdomen, the dorsopleural region obscure yellow; ventral pleural region clear light yellow. Halteres black. Legs

with the coxæ and trochanters light yellow; femora black, their bases restrictedly pale; tibiæ black, the tips paling to yellowish white, this subequal in amount on all legs and including about the distal fourth or fifth; tarsi similarly yellowish white. Wings (Plate 1, fig. 2) with a strong blackish suffusion, the oval stigma darker; conspicuous whitish streaks in the proximal ends of cells R, M, Cu, and both anals; veins brownish black. Venation: Sc long, Sc_1 ending shortly before the fork of Rs, Sc_2 at its tip; Rs long, arcuated; free tip of Sc_2 and R_2 in transverse alignment; m-cu just beyond the fork of M; vein 2d A converging toward 1st A at base.

Abdominal tergites brownish black, the sternites yellow. Ovipositor with the tergal valves relatively small, strongly upcurved; sternal valves straight, their bases blackened.

LUZON, Laguna Province, above Ube, February, 1930 (*McGregor*) ; holotype, female.

Limonia (*Limonia*) *latiflava* is very different from other regional species of the subgenus, the most distinctive characters being the very extensive pale apices of all the legs, the coloration involving not only the entire tarsi but also the tips of the tibiæ.

LIMONIA (LIMONIA) FLAVOHUMERALIS sp. nov. Plate 1, fig. 3; Plate 2, fig. 27.

General coloration black, the humeral and lateral regions of the præscutum broadly and conspicuously light yellow; pleura with a broad black longitudinal stripe; wings dark gray, the margins still darker; Sc long, Sc_2 at tip of Sc_1; male hypopygium with the ventral dististyle small, the rostral prolongation long, without spines.

Male.—Length, about 3.5 millimeters; wing, 4.2.

Rostrum and palpi black. Antennæ black; flagellar segments oval, passing into more elongate-oval; terminal segment elongate, about one-half longer than the penultimate, the distal end pointed; verticils short. Head large, especially the eyes; dorsum dark gray, the anterior vertex reduced to a capillary strip.

Pronotum black, the posterior notum yellow. Mesonotal præscutum light yellow, including the very broad humeral and lateral portions; a triangular brownish black median shield on posterior half, this sending a scarcely apparent vitta cephalad to the margin; scutal lobes blackened, the median area testaceous, the lateral margins yellow; scutellum brownish black; postnotal mediotergite testaceous brown. Pleura with the dorsal

portion occupied by a broad black longitudinal stripe that extends from the pronotum to the abdomen, encircling the root of the halteres; sternopleurite and meral region pale yellow; dorsopleural region adjoining the wing root obscure yellow. Halteres infuscated. Legs with the fore coxæ darkened, the other coxæ and all trochanters yellow; femora dark brown, the bases narrowly obscure yellow; remainder of legs brownish black, the tarsi very insensibly paler; claws nearly simple. Wings (Plate 1, fig. 3) with the disk dark gray, the margins more infuscated; stigma subcircular, darker brown; conspicuous dusky seams along vein Cu in cell M, along Rs and the cord; veins brownish black. Costal fringe short; macrotrichia of veins long and conspicuous. Venation: Sc long, Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 at its tip; cell 1st M_2 closed, relatively short; m-cu close to fork of M; cell 2d A narrow, the veins gently converging near origin.

Abdomen brownish black; hypopygium dark. Male hypopygium (Plate 2, fig. 27) with the tergite, *9t*, transverse, the caudal margin convexly rounded, with a deep and narrow median incision. Basistyle, *b*, relatively large, especially the large, obtuse, ventromesal lobe. Dorsal dististyle a short, stout, flattened blade, the apex suddenly narrowed to an acute point. Ventral dististyle small, oval, much smaller than the basistyle, the body of the style with long coarse setæ; rostral prolongation long and slender, without rostral spines. Gonapophyses, *g*, with the mesal-apical angle a stout lobe.

LUZON, Laguna Province, above Ube, at foot of Mount Banahao, altitude about 700 meters, in cool forest, February 9, 1930 (*McGregor*); holotype male.

Limonia (*Limonia*) *flavohumeralis* is most similar in general coloration to *L.* (*L.*) *retrusa* Alexander (Luzon), differing very notably in all details of coloration and structure of the male hypopygium.

LIMONIA (LIMONIA) CANIS sp. nov. Plate 1, fig. 4; Plate 2, fig. 28.

Allied to *L. cynotis;* general coloration dark brown; wings with a strong blackish tinge, without stigmal darkening; free tip of Sc_2 far before R_2; male hypopygium with the ventromesal lobe of basistyle long and slender; dististyle single, shaped more or less like a dog's ear, the mesal face on apical half with spinous setæ.

Male.—Length, about 4 millimeters; wing, 4.6.

Rostrum and palpi dark brown. Antennæ black throughout; basal flagellar segments subglobular, passing to oval outwardly; terminal segment scarcely longer than the penultimate; segments densely clothed with microscopic black setulæ and a few stout verticils of moderate length. Head dull black.

Mesonotum chiefly brownish black, the pleura paler, more obscure testaceous. Halteres infuscated. Legs with the coxæ and trochanters testaceous yellow; remainder of legs dark brown. Wings (Plate 1, fig. 4) with a strong blackish suffusion, without a stigmal darkening; veins darker brown. Venation: Sc long, Sc_1 ending at about two-thirds to three-fourths the length of the nearly straight Rs, Sc_2 at its tip; free tip of Sc_2 far before level of R_2; m-cu close to fork of M; anal veins nearly parallel to very weakly convergent at origin.

Abdomen brownish black. Male hypopygium (Plate 2, fig. 28) generally as in *L. cynotis* in the conformation of the styli, differing conspicuously in details. Tergite, *9t*, large, narrowed outwardly, the caudal margin with a broad U-shaped emargination. Basistyle, *b*, with the ventromesal lobe very long and slender, only a little shorter than the dististyle, narrowed outwardly. Dististyle, *d*, single, shaped more or less like a dog's ear, the spinous setæ on mesal face restricted to distal half. Gonapophyses, *g*, pale, the mesal-apical lobe slender, the tip produced slightly laterad into a point.

LUZON, Laguna Province, above Ube, at foot of Mount Banahao, altitude about 700 meters, near river in cool forest, February 9, 1930 (*McGregor*); holotype, male.

Limonia (*Limonia*) *canis* is allied to *L.* (*L.*) *cynotis* Alexander (Mindanao), differing most evidently in the structure of the male hypopygium, especially the long ventromesal lobe of the basistyle and the vestiture of the dististyle.

LIMONIA (RHIPIDIA) MORIONELLA (Edwards).

Rhipidia (*Rhipidia*) *morionella* EDWARDS, Journ. Fed. Malay States Mus. 14 (1928) 70.

LUZON, Mountain Province, Benguet, Mount Santo Tomas, altitude over 5,000 feet, March 21 to 24, 1930 (*Rivera*); Tayabas Province, Candelaria, June 25, 1930 (*McGregor and Rivera*).

These agree exactly with the types from the Federated Malay States except that the second tarsal segment is darkened.

LIMONIA (RHIPIDIA) LUTEIPLEURALIS sp. nov. Plate 1, fig. 5.

Belongs to the *rostrifera* group; closely allied to *L. morionella;* general coloration black, the thoracic pleura yellow, only the ventral sternopleurite darkened; wings unmarked except for stigma; terminal tarsal segments whitish.

Male.—Length, about 3.5 to 3.8 millimeters; wing, 4 to 4.4.

Female.—Length, about 4 millimeters; wing, 3.8 to 4.

Closely allied to *L. morionella;* differing especially in the yellowish thoracic pleura.

Rostrum longer than the remainder of head, black. Antennæ black, the apices of the axial portions of the segments paler; antennæ of male long-bipectinate; of female, simple. Head black.

Mesonotum brownish black, the pleura obscure yellow, only the ventral sternopleurite darkened. Halteres dusky, the base of stem restrictedly pale. Legs with the coxæ and trochanters yellow; remainder of legs black, the femoral bases restrictedly brightened; subterminal tarsal segments restrictedly whitish, more extensive and clearer white on posterior legs where from one-fourth to one-third of the tarsus is this color. Wings (Plate 1, fig. 5) whitish hyaline, unmarked except for the conspicuous short-oval brown stigma; veins brownish black. Venation: Sc_1 ending about opposite one-third the length of Rs, Sc_2 far from its tip, Sc_1 alone being one-half longer than Rs; cell M_2 open by the atrophy of m; cell 2d A wide.

Abdominal tergites dark brown, the sternites more yellow. Male hypopygium dark brown. Ovipositor with the genital shield blackened, the valves paling to horn-color.

LUZON, Mountain Province, Benguet, Mount Santo Tomas, altitude over 5,000 feet, March 21 to 25, 1930 (*Rivera*); holotype, male; allotype, female; paratypes, numerous males and females.

Although closely allied to *L.* (*R.*) *morionella* (Edwards), I must consider the present fly to be distinct by reason of the yellow thoracic pleura. The amount of white on the tarsi is more restricted and obscured in the present species. It should be observed that following the inclusion of *Rhipidia* as a subgenus of *Limonia* (*Limnobia*), *morionella* Edwards (1928) becomes preoccupied by *morionella* Schiner (1868) and should be renamed. The members of the *rostrifera* group do not seem to be strictly consubgeneric with *Rhipidia* but rather to represent a distinct off-shoot of the genus.

LIMONIA (GERANOMYIA) PHŒNOSOMA sp. nov. Plate 1, fig. 6; Plate 2, fig. 29.

General coloration reddish; head blackish gray with a silvery median vitta; postnotal mediotergite dark brown; knobs of halteres blackened; wings with a faint brown tinge, sparsely marked with small brown clouds that are distributed in the costal field; male hypopygium with the cephalic margin of the rostral prolongation of ventral dististyle with sclerotized bracing areas; rostral spines very elongate; gonapophyses with apices of mesal-apical lobes bifid.

Male.—Length, excluding rostrum, about 5.5 millimeters; wing, 5.6; rostrum, about 2.2 to 2.3.

Female.—Length, excluding rostrum, about 5.5 to 7 millimeters; wing, 5.5 to 6.3; rostrum, about 2.4 to 2.8.

Rostrum and palpi black, the former of moderate length only, slightly longer in the female. Antennæ black throughout; flagellar segments oval to subcylindrical, the verticils short and inconspicuous. Front and anterior vertex silvery; remainder of head blackish gray, with a silvery median vitta to the occiput; anterior vertex narrow.

Mesonotum shiny reddish yellow, the disk of the præscutum and the scutal lobes darker, more chestnut-red, the lateral portions more yellowish; scutellum obscure yellow, darker basally; postnotal mediotergite conspicuously dark brown, the lateral portions yellow. Pleura reddish yellow. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters yellow; femora obscure yellow, more brownish on distal half; tibiæ and tarsi brownish yellow, the terminal segments darkened; claws with a powerful basal tooth, with an additional microscopic denticle more proximad. Wings (Plate 1, fig. 6) with a faint brown tinge, sparsely patterned with brown, including the stigma and small spots at origin of Rs, fork of Sc, along anterior cord, and as a marginal seam in the radial field; narrow and less conspicuous seams to the supernumerary crossvein in cell Sc, along posterior cord, and on outer end of cell 1st M_2; veins brownish black. Costal fringe short. Venation: Sc long, Sc_1 ending at near four-fifths the length of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc at about two-thirds the length of vein R; Rs weakly angulated at origin; cell 1st M_2 closed; m-cu at or before the fork of M; cell 2d A narrow, the anal veins at base generally parallel.

Abdominal tergites brownish black, the basal segments a little brightened laterally at the incisures; sternites yellow; outer segments of abdomen paler in both sexes. Male hypopygium (Plate 2, fig. 29) with the tergite, *9t*, transverse, the caudal margin convexly rounded, divided by a small median notch into two halves that are provided with abundant setæ. Basistyle, *b*, relatively small, the ventromesal lobe large, conspicuously setiferous. Dorsal dististyle a very strongly curved chitinized sickle, the acute tip blackened. Ventral dististyle, *vd*, fleshy, oblique, the conspicuous rostral prolongation protected along its cephalic margin by sclerotized areas; two very long, curved, rostral spines, arising from a common basal tubercle, placed near apex of the prolongation. Gonapophyses, *g*, with the mesal-apical lobes conspicuously bifid at apex.

LUZON, Laguna Province, above Ube, February 6 to 12, 1930 (*McGregor and Rivera*); holotype, male; allotype, female; paratype, female; Tayabas Province, Candelaria, June 25, 1930 (*McGregor and Rivera*); paratype, female.

Limonia (*Geranomyia*) *phœnosoma* is readily told by the peculiar structure of the male hypopygium.

LIMONIA (GERANOMYIA) LONGIFIMBRIATA sp. nov. Plate 1, fig. 7; Plate 2, fig. 30.

General coloration yellow; mesonotal præscutum with three gray stripes that are separated by two narrow blackish lines; halteres dusky; wings with a faint brownish tinge, very sparsely patterned with brown; costal fringe (male) very long and conspicuous; cell M_2 open by the atrophy of m; male hypopygium with the ventral dististyle large and fleshy; spines of the rostral prolongation from long basal tubercles that are widely separated; mesal-apical lobe of gonapophyses very long and slender.

Male.—Length, excluding rostrum, about 6 millimeters; wing, 6 to 6.2; rostrum, about 2.5.

Female.—Length, excluding rostrum, about 5 millimeters; wing, 6.2; rostrum, about 2.

Rostrum and palpi black. Antennæ black throughout; flagellar segments cylindrical with short inconspicuous verticils. Head blackish gray; a narrow silvery line from the front to the occiput.

Pronotum blackish gray. Mesonotal præscutum with three gray stripes, the interspaces dull black, the humeral and lateral regions obscure yellow; scutum obscure yellow, the lobes extensively blackish gray; scutellum testaceous; postnotal medioter-

gite dark brown, especially on the posterior half. Pleura obscure yellow, the pleurotergite a trifle darkened. Halteres dusky. Legs with the coxæ and trochanters pale greenish yellow; remainder of legs dark brown, the femoral bases restrictedly brightened; basal tarsal segments paling to brownish yellow. Wings (Plate 1, fig. 7) with a faint brown tinge; stigma oval, dark brown; a vague gray clouding along cord; wing apex in radial field narrowly bordered by brown; veins dark brown. Costal fringe (male) very long and conspicuous. Venation: Sc long, Sc_1 ending about opposite or beyond midlength of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc; cell M_2 open by the atrophy of m; m-cu at or close to the fork of M.

Abdominal tergites dark brown, the sternites greenish yellow. Male hypopygium (Plate 2, fig. 30) with the caudal margin of tergite gently emarginate, with two low lobes. Basistyle, *b*, relatively small, the ventromesal lobe moderately large. Ventral dististyle, *vd*, a very large fleshy lobe, the rostral prolongation large, complex in structure, the two spines arising from widely separated pale tubercles, the inner spine shorter. Dorsal dististyle a strongly curved pale sickle, the tips slightly upcurved. Gonapophyses, *g*, with the mesal-apical lobe very long and slender, gently curved.

LUZON, Laguna Province, Mount Maquiling, May 23 to 30, 1930 (*Duyag*); holotype, male; paratype, male; above Ube, altitude 400 meters, January 27, 1930 (*McGregor*), paratype, male; Pampanga Province, Mount Arayat, October, 1929 (*Rivera*); allotype, female.

Limonia (*Geranomyia*) *longifimbriata* is very distinct from regional species in the unusually long costal fringe in the male and the open cell M_2.

LIMONIA (GERANOMYIA) PARAMANCA sp. nov. Plate 1, fig. 8.

Belongs to the *argentifera* group; allied to *L. manca* in the open cell M_2; wings with a strong dusky tinge, the stigma and a broad marginal seam in cell R_2 darker brown.

Female.—Length, excluding rostrum, about 4.8 millimeters; wing, 4.5; rostrum, about 2.5.

Rostrum long, black; palpi black. Antennæ black throughout, the verticils short. Head gray, the front and anterior vertex silvery; central portion of posterior vertex extensively blackened.

Mesonotum polished black, the præscutum with a silvery area on sides behind pseudosutural foveæ, with a smaller similar

sublateral area at suture; scutellum and postnotum more pruinose. Pleura heavily silvery pruinose, the sternal region paler. Halteres yellow. Legs with the coxæ and trochanters yellow; femora obscure yellow, slightly darker beyond base; remainder of legs brown. Wings (Plate 1, fig. 8) with a strong dusky tinge, the stigma and a broad marginal seam in cell R_2 darker brown; veins brownish black. Costal fringe relatively long and conspicuous for the female sex. Venation: Sc_1 ending beyond midlength of Rs; an unusually wide supernumerary crossvein in cell Sc at near two-thirds the length of vein R; cell M_2 open by the atrophy of m; m-cu about one-half its length beyond the fork of M, the distal section of Cu_1 very short; cell 2d A narrow.

Abdominal tergites black, the sternites paler, more brownish; genital segment brownish yellow. Ovipositor with the tergal valves very slender, gently upcurved, reddish horn color.

LUZON, Tayabas Province, Candelaria, June 25, 1930 (*McGregor and Rivera*); holotype, female.

Limonia (*Geranomyia*) *paramanca* is readily distinguished from the other members of the *argentifera* group by the darkened wings, in conjunction with the small size and open cell M_2. The other members of the group, with the exception of *manca* Alexander (North Queensland) have cell 1st M_2 closed (*argentifera* de Meijere, *nigronotata* Brunetti, *nigronitida* Alexander, and *pleuropalloris* Alexander). As I have indicated in another paper, a study of the type specimen of *sorbillans* (Wiedemann) shows that it, too, belongs to this group and is very probably identical with *argentifera*. The type is a female, in relatively poor condition, and the synonymy cannot be readily affirmed.

LIMONIA (PSEUDOGLOCHINA) ANGUSTAPICALIS sp. nov. Plate 1, fig. 9; Plate 2, fig. 31.

General coloration dark brown, the pronotum and broad pleural region yellow; fore femora white, the tips narrowly blackened; posterior femora dark brown; remainder of legs snowy white, all tibiæ with a single narrow black ring at midlength; wings whitish, the large stigma and narrow apex blackened; abdominal sternites distinctly bicolored; male hypopygium with a single stout rostral spine.

Male.—Length, about 5 millimeters; wing, 5.5.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum pale yellow; palpi black. Antennæ black throughout, relatively elongate, the long-oval segments with short apical pedicels. Head yellow, more dusky on the orbits.

Pronotum light yellow. Mesonotum dark brown, with a more or less distinct paler median line from the posterior portion of the præscutum to the postnotal mediotergite where it becomes more pruinose. Pleura chiefly occupied by a broad yellow longitudinal stripe, more pruinose on its ventral portion; dorsal pleurotergite and ventral sternopleurite dark brown. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters brownish yellow; fore femora white, the tips narrowly blackened; posterior femora dark brown, the tips narrowly blackened; all tibiæ snowy white with a single narrow black ring at midlength; tarsi snowy white. Wings (Plate 1, fig. 9) whitish, the apex in outer radial cells darkened; stigma large, dark brown; veins black, the prearcular veins R whitish. Venation: Sc_1 ending just beyond the fork of the short oblique Rs; cell 2d M_2 deep; m-cu at fork of M; cell 2d A small, as in *L. unicinctipes*.

Abdominal tergites dark brown, the intermediate segments with a paler brown subterminal area; subterminal segments blackened; sternites bicolored, the bases broadly black, the tips about equally yellowish white; ventral dististyle pale yellow. Male hypopygium (Plate 2, fig. 31) with the ventral dististyle, *vd*, large and fleshy, the rostral prolongation small, with a single short powerful spine. Gonapophyses broad-based, the mesal-apical angle small.

LUZON, Laguna Province, Mount Maquiling (*Duyag*); holotype, male; allotype, female, January 28, 1930; paratype, male, May 23 to 30, 1930 (*Duyag*).

Limonia (*Pseudoglochina*) *angustapicalis* is most closely allied to *L.* (*P*). *unicinctipes* Alexander, differing most conspicuously in the large stigmal area, distinctly darkened apex of the wings, and the dimidiate abdominal sternites.

LIMONIA (ALEXANDRIARIA) SOLLICITA sp. nov. Plate 1, fig. 10.

General coloration gray; antennæ black throughout; knobs of halteres dark brown; legs yellow, the terminal three tarsal segments dark brown; wings gray, sparsely patterned with brown; Sc short, Sc_1 very long; a marginal spur of vein M_3 persisting.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum black, the labial palpi brown, the maxillary palpi black. Antennæ black throughout; flagellar segments oval, more elongate outwardly, the terminal segment a little longer than the penultimate. Head gray; anterior vertex narrow.

Pronotum and mesonotum brown, the three præscutal stripes darker brown but almost concealed by yellowish pollen; scutal

lobes brownish black, the median area paler; scutellum brownish gray; postnotum dark gray. Pleura gray. Halteres short, obscure yellow, the knobs dark brown. Legs with the coxæ brownish yellow, the fore coxæ somewhat darker; trochanters yellow; remainder of legs yellow, the three terminal tarsal segments infuscated; third and fourth tarsal segments on flexor surface with rows of evenly spaced pale spines on the entire length of the segment; claws small, with a single well-developed tooth. Wings (Plate 1, fig. 10) gray, sparsely patterned with brown; stigma oval, brown; restricted grayish brown clouds at Sc_2, origin of Rs, and along cord; veins dark brown. Venation: Sc short, Sc_1 ending opposite the origin of Rs, very long, Sc_2 being at near midlength of R; a marginal spur of M_3 back from wing edge; m-cu close to fork of M; cell 2d A wide.

Abdominal tergites dark brown, the sternites brownish yellow. Ovipositor with the tergal valves very slender, the sternal valves correspondingly stout and deep.

LUZON, Laguna Province, Ube, December, 1929 (*Rivera*); holotype, female.

Limonia (*Alexandriaria*) *sollicita* is very different from the other regional species of the subgenus. The wing pattern is almost as in *L.* (*Dicranomyia*) *sordida* (Brunetti) and similar species. It is uncertain as to how constant the presence of the marginal vein M_3 will prove to be.

ORIMARGA (ORIMARGA) RUBRICOLOR sp. nov. Plate 1, fig. 11.

General coloration red; antennæ black throughout; wings milky gray, the veins pale; macrotrichia of veins relatively sparse, there being only about four on the distal half of R_3.

Male.—Length, about 3.2 millimeters; wing, 3.8.

Female.—Length, about 3.6 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments subglobular, passing into oval outwardly. Head gray.

Thoracic dorsum reddish brown, the pleura clearer red. Halteres pale. Legs with the coxæ reddish; trochanters testaceous; remainder of legs pale brown, long and slender. Wings (Plate 1, fig. 11) milky gray, the prearcular and costal regions light yellow; veins pale. Costal fringe relatively long and conspicuous. Macrotrichia of veins relatively sparse, there being four on distal half of R_3, widely separated; a series of about twenty to twenty-five the entire length of the distal section of R_{4+5}, more crowded toward outer end; additional trichia on outer half

of each of veins M_{1+2} and M_3. Venation: Sc_1 ending about opposite three-fifths the length of Rs, Sc_2 not far from its tip; R_2 a trifle shorter than R_{2+3}; basal section of R_{4+5} about twice R_{2+3}; m-cu opposite the proximal third of Rs.

Abdomen entirely red in male, the subterminal segments of female blackened.

LUZON, Tayabas Province, Candelaria, June 25, 1930 (*McGregor and Rivera*); holotype, male; allotype, female. "This red fly is found on damp mossy rocks at streamside."—McGregor.

Orimarga rubricolor is readily told by the conspicuous red coloration of the body.

HELIUS (RHAMPHOLIMNOBIA) RETICULARIS (Alexander).

Rhampholimnobia reticularis ALEXANDER, Proc. U. S. Nat. Mus. **49** (1915) 169–170.

One male, Pakawan, Ifugao Subprovince, Mountain Province, Luzon, April 7, 1930 (*Rivera*). The species and the subgenus are new to Luzon and the Philippines, having previously been recorded only from Java (type locality) and Borneo.

HEXATOMINI

EPIPHRAGMA (POLYPHRAGMA) BAKERI Alexander. Plate 1, fig. 12; Plate 2, fig. 32.

Epiphragma bakeri ALEXANDER, Philip. Journ. Sci. 21 (1922) 373–374.

A male from Pauai, Mountain Province, Luzon, altitude 8,000 feet, April 11, 1930 (*Rivera*), is generally similar to the holotype male except in the more-restricted brown wing pattern. The venation (Plate 1, fig. 12) has never been shown. The male hypopygium (Plate 2, fig. 32) is very different from that of the other Luzon species of the subgenus so far described. Region of the tergite, *9t*, produced medially into a shield-shaped area, the caudal margin of which is deeply notched. Basistyle, *b*, with a small fleshy lobe on mesal face at base. Interbasal process, *i*, expanded on basal half, the apex unequally bidentate. Outer dististyle, *od*, a small bottle-shaped structure, the apex bent at a right angle into two subequal teeth. Inner dististyle, *id*, larger, flattened. Ædeagus large, with an irregular elevated crest.

EPIPHRAGMA (POLYPHRAGMA) PARVILOBA sp. nov. Plate 1, fig. 13; Plate 2, fig. 33.

Male.—Length, about 6.5 to 7 millimeters; wing, 7.5 to 8.

Generally similar to *E.* (*P.*) *ochrinota* Alexander in the general coloration of the body, differs most conspicuously in the dark

antennæ, narrow anterior vertex, wing pattern, and details of the male hypopygium.

Antennal scape black, the fusion segment infuscated, in cases a little brightened beneath. Head brownish gray, the anterior vertex very narrow, the eyes unusually large.

Mesonotum fulvous, contrasting markedly with the black pleura. Femora yellow, the subterminal darkening relatively pale and ill-defined. Wings (Plate 1, fig. 13) grayish, the costal region light yellow; a diffuse brown pattern, darker and more clearly delimited along the costal margin, the markings of the disk not bordered by yellow, as is the case in *E. ochrinota*.

Male hypopygium (Plate 2, fig. 33) with the median tergal lobes, *9t*, very small, separated by a broad U-shaped notch. Basistyles very long and slender. Outer dististyle, *od*, dilated at midlength, setiferous, thence narrowed to an acute curved point, with a small lateral tubercle before apex. Interbasal process, *i*, a long simple spine, more slender than in *ochrinota*. Phallosome, *p*, with the ædeagus set in a deep notch in the quadrate plate.

LUZON, Laguna Province, above Ube, foot of Mount Banahao, altitude 400 to 700 meters, February 3 to 9, 1930 (*McGregor and Rivera*); holotype, male; paratypes, 3 males. The holotype was taken at 700 meters, in flight near river in cool forest.

LIMNOPHILA (EPHELIA) IGOROTA sp. nov. Plate 1, fig. 14; Plate 3, fig. 34.

Antennal scape black, the flagellum chiefly pale; mesonotal præscutum yellow, with abundant dark markings; knobs of halteres blackened; femora yellow, the tips more yellowish brown, with a very narrow black subterminal ring; wings broad in male, the dark pattern compact; seam on m-cu narrow, disconnected with the major area on the anterior cord.

Male.—Length, about 5.5 millimeters; wing, 6.5

Female.—Length, about 7 millimeters; wing, 7.5

Antennæ with the scapal segments dark brown, the first segment pruinose; flagellum with the basal six to eight segments light yellow. Head yellow, mottled with blackish.

Mesonotal præscutum with the ground color yellow, the usual stripes much dissected; lateral stripes entire, connected at anterior ends with the pseudosutural foveæ and confluent laterally with the broad dark brown lateral margins of the sclerite; median præscutal stripe blackened behind the level of the pseudosutural foveæ, the anterior portion wider, more grayish yellow, mottled with darker dots and with a capillary black vitta; in-

terspaces behind the pseudosutural foveæ with four or five dots that are in part confluent. Pleura gray, with numerous conspicuous brown spots that scarcely assume the form of a stripe. Halteres with the knobs black. Legs with the femora yellow, the tips light yellowish brown, the proximal end of this darkened ring narrowly blackened, as in *L. granulata.* Wings (Plate 1, fig. 14) of male broader than in female; dark pattern more restricted to the costal half, especially of the area along the cord, which forms an almost solid mass that extends back to the fork of M, the clear area in cell C greatly restricted, not reaching any of the veins of Rs; the very narrow seam along m-cu is not connected with the mark along the anterior cord, the Y-shaped figure in *granulata* thus appearing more V-shaped; seam on m-cu not in alignment with the anterior cord, being at or beyond midlength of cell 1st M_2; dark seam on the supernumerary crossvein in cell M a little distad of the general level of the dark areas that form the first crossband; dark spot beyond the prearcular area very small and inconspicuous.

Male hypopygium with the apical notch of the outer dististyle, *od* (Plate 3, fig. 34), broad and shallow, the margin irregular, the outer apical angle a decurved spine, preceded by a group of from five to seven smaller appressed spines; on lateral margin of style at near midlength with a conspicuous appressed spinous lobe.

LUZON, Mountain Province, Benguet, La Trinidad, below Baguio, altitude 4,800 feet, in open parklike area, March 26, 1930 (*Rivera*) ; holotype, male; allotype, female; Mount Santo Tomas, above Baguio, altitude over 5,000 feet, March 21, 1930 (*Rivera*) ; paratype, female; Pauai, April 21, 1930 (*Rivera*) ; paratype, 1 male; Laguna Province, above Ube, altitude 1,500 feet, February 11, 1930 (*Rivera*) ; paratypes, 2 males.

Limnophila (*Ephelia*) *igorota* is closely allied to the Bornean *L.* (*E.*) *granulata* Edwards, differing especially in the details of wing pattern and venation, the black knobs of the halteres, and other details.

PILARIA PHŒNOSOMA sp. nov. Plate 1, fig. 15; Plate 3, fig. 35.

General color red; antennæ short in both sexes; halteres black; wings with a strong brown tinge; vein R_3 very short, not exceeding one-third the length of the long R_4, cell R_3 at margin thus being very wide; cell M_1 lacking.

Male.—Length, about 7.5 to 8.5 millimeters; wing, 7 to 8.5.

Female.—Length, about 10 millimeters; wing, 7.5.

Rostrum and palpi black. Antennæ short in both sexes; scapal segments reddish brown; flagellum black; flagellar segments short and crowded, the outer segments passing into cylindrical; all segments with long conspicuous verticils that exceed the segments. Head fiery orange; vertex broad.

Thoracic dorsum fiery reddish orange, the præscutum without distinct stripes except a vague median capillary darkening; pseudosutural foveæ extensive but pale reddish and so inconspicuous; tuberculate pits at cephalic margin of sclerite reddish; scutellum brownish testaceous. Pleura reddish, vaguely marked with darker on the anepisternum and sternopleurite, the posterior sclerites more testaceous. Halteres black, the extreme base of stem brightened. Legs with the coxæ and trochanters obscure yellow; femora obscure brownish yellow, the tips narrowly blackened; tibiæ and tarsi black. Wings (Plate 1, fig. 15) with a strong brownish tinge, the small oval stigma darker brown; prearcular and costal regions a little brighter, especially before and beyond the stigma; conspicuous longitudinal hyaline obliterative streaks in cells R, R_3, M, 1st M_2, M_3, and M_4; veins dark brown. Venation: Sc relatively long, Sc_1 ending opposite the fork of Rs, Sc_2 some distance from its tip, Sc_1 alone exceeding R_{2+3+4}; R_3 very short, not exceeding one-third the length of the long R_4, cell R_3 at margin, thus being very wide; cell M_1 lacking; m-cu about one-third to one-half its length beyond the fork of M; anterior arculus preserved.

Abdomen reddish, the caudal margins of the tergites narrowly but conspicuously blackened; hypopygium orange-yellow. Male hypopygium (Plate 3, fig. 35) with the tergite, *9t*, conspicuous, the median portion of the caudal margin produced into a broad lobe that is further produced into two submedian glabrous plates, their tips obtuse, these plates separated by a deep notch. Basistyles, *b*, short and stout. Dististyles, *id*, *od*, as figured, the inner style very broad.

LUZON, Laguna Province, Ube, February 11 to May 9, 1930 (*McGregor and Rivera*); holotype, male; allotype, female; paratopotypes, 15 of both sexes.

Pilaria phœnosoma is very different from all described members of the genus, in some respects more resembling a small *Eriocera*. The following notes on the occurrence of this species are of much interest: "The water supply for Majayjay comes from a large spring near Ube. The overflow runs off in a small stream and is used for irrigation. Just below the spring is

a small bog (area approximately one hectare). Some of this is open, with growth of ferns, sedges, and small shrubs. A large part is covered with a bamboo and pandan thicket. Many of the mountain streams are dry this month (March), but this spring seems to have the same overflow as in the rainy months. In ferns and other low vegetation along this stream and in plants on this boggy area, many large and small tipulids occurred."—McGregor. Associated with the *Pilaria* in this habitat on March 4, 1930, were the following Tipulidæ: *Limonia* (*Geranomyia*) *argentifera* (de Meijere), *L.* (*Goniodineura*) *nigriceps* (van der Wulp), *L.* (*Thrypticomyia*) *apicalis* (Wiedemann), *Conosia irrorata* (Wiedemann), *Trentepohlia* (*Trentepohlia*) *trentepohlii* (Wiedemann), *Gonomyia* (*Lipophleps*) *bicolorata* Alexander, and *Erioptera* (*Erioptera*) *rubripes* Alexander.

PILARIA CARBONIPES sp. nov. Plate 1, fig. 16.

General coloration of mesonotum polished black, the thoracic pleura abruptly yellow; antennæ (male) elongate; halteres and legs black; wings with a blackish tinge; R_2 shorter than R_{2+3}; cell M_1 present; hypopygium black.

Male.—Length, about 4 to 4.2 millimeters; wing, 4.3 to 5; antennæ, 2.3 to 2.6.

Female.—Length, about 5 millimeters; wing, 4.6 to 5.

Antennæ (male) elongate, much exceeding one-half the length of the body, black throughout; flagellar segments cylindrical to elongate-fusiform, with dense erect black setæ and slightly longer verticils. In the female the antennæ are shorter, about equal to the combined head and thorax, the setæ lacking or inconspicuous, the verticils very long and evident. Head polished black.

Mesonotum polished black, the humeral region of præscutum very restrictedly pale. Pleura, including the pleurotergite, yellow. Halteres blackened. Legs with the coxæ and trochanters obscure yellow; remainder of legs black, only the femoral bases restrictedly obscure yellow. Wings (Plate 1, fig. 16) with a strong blackish tinge, the oval stigma slightly darker brown; veins brownish black. Venation: Sc_1 ending about opposite four-fifths the length of Rs, Sc_2 at its tip; R_{2+3} present, a little longer than R_2 alone; R_3 long, straight or weakly sinuous; inner ends of cells R_4, R_5, and 1st M_2 in oblique alignment, the last most basad; cell M_1 slightly longer than its petiole; m-cu beyond midlength of cell 1st M_2.

Abdominal tergites and hypopygium black, the sternites abruptly light yellow.

LUZON, Laguna Province, above Ube, February 11 to April 14, 1930 (*McGregor and Rivera*); holotype, male; allotype, female; paratypes, 6 of both sexes; Mount Maquiling, January 28, 1930 (*Duyag*); paratype, female.

Pilaria carbonipes is somewhat similar to the Japanese *P. melanota* Alexander, differing in the more-blackened notum, the black legs, and strongly infumed wings, with the venational details quite distinct, notably the position of R_2 and the course of R_3.

PILARIA CARBONIPES HOLOMELANIA subsp. nov.

As in the typical form, but the pleura and pleurotergite polished black. The legs, especially the tarsi, paler, the tarsi fading to yellowish white.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,800 feet, July 3, 1930 (*Clagg*); holotype, male; allotype, female; paratypes, 1 male, 1 female.

PILARIA ALBOPOSTICATA sp. nov.

Male.—Length, about 5 to 5.2 millimeters; wing, 6; antennæ, 2.8 to 3.

Female.—Length, about 5.5 millimeters; wing, 5.5.

Characters much as in *P. carbonipes* sp. nov., differing as follows: Legs black, the femoral bases obscure yellow, especially the posterior femora; tarsi black, the posterior tarsi conspicuously whitish yellow, the two terminal segments darkened.

LUZON, Laguna Province, above Ube, February, 1930 (*Rivera*); holotype, male; paratypes, 3 males; Mountain Province, Benguet, La Trinidad, below Baguio, altitude 4,800 feet, March 26 to 28, 1930 (*Rivera*); allotype, female; paratypes, 3 of both sexes.

The conspicuous pale coloration of the posterior tarsi is distinctive of the species.

ERIOPTERINI

GONOMYIA (LIPOPHLEPS) MAQUILINGIA sp. nov. Plate 1, fig. 17; Plate 3, fig. 36.

General coloration brownish gray; rostrum orange; antennæ black throughout; thoracic pleura indistinctly variegated yellowish testaceous and pale brown; legs brownish black; wings tinged with brownish gray, the stigma only vaguely darker; Sc short; male hypopygium with a single small subterminal dis-

tistyle; phallosomic structure terminating in a median organ shaped like a tuning fork.

Male.—Length, about 3 millimeters; wing, 3.

Rostrum orange; palpi black. Antennæ black throughout. Head chiefly gray.

Mesonotum brownish gray, the median region of the scutum slightly paler; posterior callosities of scutal lobes and the scutellum obscure yellow, the median region of the latter at base darkened; postnotal mediotergite pruinose. Pleura vaguely patterned with yellowish testaceous and pale brown, the pale coloration including the posterior sclerites; dorsal pleurites and ventral sternopleurite darkened. Halteres dusky, the base of stem restrictedly brightened. Legs with the coxæ and trochanters testaceous-brown; remainder of legs brownish black. Wings (Plate 1, fig. 17) tinged with brownish gray, the stigma slightly and vaguely darkened; veins brown. Venation: Sc short, Sc_1 ending a short distance before origin of Rs, this distance greater than the length of the latter; Rs less than two-thirds the anterior branch of the same; cell 1st M_2 closed; m-cu before fork of M.

Abdominal tergites brown, paler laterally, the sternites more uniformly pale. Male hypopygium (Plate 3, fig. 36) with the apical lobe of basistyle, *b*, slender. Dististyle, *d*, single, pale, much shorter and more slender than the lobe of the basistyle, provided with about six setæ. Phallosomic structure, *p*, consisting of a pale fan-shaped plate, its caudal margin with four low crenulate lobes; a further median extension is shaped like a tuning fork.

LUZON, Laguna Province, Mount Maquiling, May 23 to 30, 1930 (*Duyag*); holotype, male.

Gonomyia (*Lipophleps*) *maquilingia* is generally similar to *G.* (*L*). *incompleta* Brunetti, differing decisively in the very different male hypopygium.

GONOMYIA (LIPOPHLEPS) INCOMPLETA Brunetti.

Gonomyia incompleta BRUNETTI, Fauna British India, Dipt. Nematocera (1912) 471–472.

Gonomyia (*Leiponeura*) *insulensis* ALEXANDER, Can. Ent. 45 (1913) 286–287.

LUZON, Laguna Province, Ube, February 6, 1930 (*Rivera*); Tayabas Province, Candelaria, June 25, 1930 (*McGregor and*

Rivera). This fly has a very extensive range in eastern Asia, from British India to Japan.

GONOMYIA (LIPOPHLEPS) PALLIDISIGNATA sp. nov. Plate 1, fig. 18; Plate 3, fig. 37.

General coloration brown to grayish brown; basal segments of flagellum yellow, the outer segments blackened; pleura with a whitish longitudinal stripe; legs with the femora pale brown, the tips whitish, inclosing a very broad black subterminal ring; tibiæ pale brown, the tips narrowly pale yellow; wings white, clouded with pale brown; Rs from one-third to one-half longer than the petiole of cell R_3; male hypopygium with three dististyles.

Male.—Length, about 2.8 millimeters; wing, 3.

Female.—Length, about 3.5 millimeters; wing, 3.5.

Rostrum and palpi black. Antennæ with the scape above and basal two segments of flagellum yellow, the remainder of the organ blackened. Head white, the center of the vertex extensively blackened.

Pronotum and anterior lateral pretergites white. Mesonotum brown, varying from reddish brown to dark grayish brown, the scutal lobes darker; scutellum obscure white, the median area darkened at base; postnotum dark. Pleura brown to brownish black, usually blue-gray pruinose, with a narrow, conspicuous, longitudinal white stripe extending from and including the fore coxæ, passing beneath the halteres, this stripe sometimes obscured or lost. Halteres yellow, the base of the club darkened. Legs with the fore coxæ white, the mid-coxæ dark brown, the posterior coxæ dark brown on basal half, white on distal half; trochanters whitish; femora beyond base pale brown, with a very broad and conspicuous black subterminal ring, preceded and followed by narrow white annuli that are less than one-third the area of the blackened annulus; tibiæ pale brown, the tips narrowly pale yellow; tarsi brown. Wings (Plate 1, fig. 18) with the ground color white, this including the prearcular, costal, and apical portions; remainder of disk clouded with pale brown, reducing the ground color to areas in both ends of cells R and M, a more or less distinct crossband beyond the cord, and the outer ends of cells Cu and 1st A; restricted darker brown areas at origin of Rs and tip of Sc, stigma, ends of veins R_3 and R_4, and along the cord; veins brown, pale in the ground areas. Venation: Sc_1 ending opposite or shortly beyond origin of Rs, the latter unusually long for this subgenus, being about one-third

to one-half longer than the straight petiole of cell R_3; R_3 short and transverse, R_4 strongly arcuated; m-cu before the fork of M.

Abdomen brownish black, including the hypopygium; caudal margins of abdominal segments narrowly and indistinctly paler. Male hypopygium (Plate 3, fig. 37) with three dististyles, the outer a long, gently curved, blackened rod; intermediate style very small, appearing as a pale spine; innermost style long-oval, terminating in two long setæ.

LUZON, Laguna Province, Ube and above, altitude 400 to 700 meters, February 6 to April 14, 1930 (*McGregor and Rivera*); holotype, male; allotype, female; numerous paratypes of both sexes.

Although closely allied to *G.* (*L.*) *nubeculosa* de Meijere, I must regard the present fly as being distinct, differing especially in the coloration of the legs and wings and the longer Rs. I do not have a male of *nubeculosa* for comparison. The African species, *G.* (*L.*) *liberiensis* Alexander, *G.* (*L.*) *noctabunda* Alexander, and *G.* (*L.*) *sobrina* Alexander, are also allied though separable on venation and structure of the male hypopygium. Edwards is entirely correct and justified in referring this group of flies with cell R_3 preserved to *Lipophleps* rather than to the typical subgenus where they had been placed by other workers.

GONOMYIA (LIPOPHLEPS) ALBOANNULATA sp. nov. Plate 1, fig. 19; Plate 3, fig. 38.

Closely related to *G. diffusa;* rostrum and palpi black; basal segments of antennal flagellum pale; thoracic pleura with a narrow white line; halteres with darkened knobs; femora brownish yellow, with a brown subterminal ring, preceded and followed by clear yellow; wings unmarked except for a vague pale brown stigmal area; anterior branch of Rs gently sinuous; male hypopygium with three dististyles, the intermediate one spinous at apex, the inner style split into three acute spines.

Male.—Length, about 2.6 millimeters; wing, 3.3.

Female.—Length, about 3 millimeters; wing, 3.2.

Rostrum relatively elongate, about one-half the remainder of head, black; palpi black. Antennæ with the scape dark brown, the basal flagellar segments pale, the outer segments passing into dark brown. Head pale, the center of the vertex restrictedly darkened.

Anterior pronotum whitish, with a darkened median spot; anterior lateral pretergites whitish. Mesonotum grayish brown, the pseudosutural foveæ dark brown; median region of scutum

and narrow posterior margin of scutellum obscure testaceous; postnotal mediotergite brownish gray, the anterior lateral angles broadly yellow. Pleura brownish black on ventral half, this inclosing a conspicuous white longitudinal stripe, bordered on either side by blackish; dorsopleural region buffy, more blackened in front. Halteres pale, the knobs brown. Legs with the fore and hind coxæ pale, the mid-coxæ dark brown; trochanters yellow; femora brown to yellowish brown, with a broad brown subterminal ring, preceded and followed by a narrow clearer yellow ring; tibiæ white, the tips narrowly blackened; tarsi white, the tips dark brown. Wings (Plate 1, fig. 19) grayish, unmarked except for a vague pale brown stigmal area; prearcular and costal regions more yellowish; veins pale brown. Venation: Sc_1 ending opposite the origin of the strongly arcuated Rs; anterior branch of Rs gently sinuous.

Abdomen of male dark brown, including the hypopygium; caudal margins of segments conspicuously ringed with pale; pleural membrane conspicuously whitened. In female, the segments are uniformly darkened, as in *diffusa*. Male hypopygium (Plate 3, fig. 38) with three dististyles, the outermost a simple blackened blade, gradually narrowed to the obtuse tip; intermediate style a little shorter, appearing as a straight rod, the distal third slightly expanded into a spinous head; innermost style, *id*, trifid, all arms acute, the laterals straight and provided with two or three setæ, the central arm curved, glabrous.

LUZON, Tayabas Province, Candelaria, along margin of stream, June 25, 1930 (*McGregor and Rivera*); holotype, male. MINDANAO, Davao district, Calian, Lawa, at trap lantern, April 24, 1930 (*Clagg*); allotype, female; paratype, female.

Gonomyia (*Lipophleps*) *alboannulata* is most closely allied to *G.* (*L.*) *diffusa* (de Meijere), differing especially in the darkened knobs of the halteres, the details of venation, as the strongly sinuous anterior branch of Rs, and the pattern of the legs and wings. I do not know the male sex of *diffusa*.

GONOMYIA (LIPOPHLEPS) LUTEIMARGINATA sp. nov. Plate 3, fig. 39.

Male.—Length, about 2.6 millimeters; wing, 3.3.

Characters as in *G. flavomarginata* (Brunetti), differing in details of coloration of the wings and legs.

Thoracic pleura plumbeous-brown, with a single narrow whitish longitudinal stripe. Legs with the femora brownish yellow, with a narrow and ill-delimited brown ring just before

the tip; tibiæ and tarsi dark brown. Wings gray, with a vague brownish gray pattern, the clearer areas lying chiefly before and beyond the cord, which is broadly and distinctly seamed with brownish gray; prearcular and costal regions pale yellowish white; whitish areas before and beyond stigma; veins very pale brown, the costal and subcostal veins pale yellow, the cord darkened. Venation: Sc_1 ending a short distance before the origin of Rs, this distance about equal to the basal section of R_5; anterior branch of Rs straight or very gently sinuous.

Male hypopygium (Plate 3, fig. 39) with the outer dististyle, *od*, a gently curved blackened rod, the apex obtuse, near base on mesal edge produced into a curved black spine, the margin with conspicuous appressed spines. Inner dististyle, *id*, a straight yellow rod, the tip produced into a small blackened recurved spine. Phallosome, *p*, terminating in two blackened points, each produced cephalad into a long black spine.

MINDANAO, Davao district, Calian, Lawa, April 24, 1930, at trap lantern (*Clagg*); holotype, male.

This species agrees very closely with *flavomarginata* (Brunetti) except in the details indicated. Edwards,[2] who examined paratypes of this species, states that all the veins of the wings are brownish. The Japanese *G.* (*L.*) *flavocostalis* Alexander is likewise generally similar but differs in all details of the male hypopygium. The outer dististyle is only weakly spinous along margin; the inner dististyle is triangular in outline, the outer end of the triangle being a long pale spine; phallosome not blackened at tips.

GONOMYIA (LIPOPHLEPS) SECRETA sp. nov. Plate 1, fig. 20; Plate 3, fig. 40.

General coloration brown; basal segments of antennæ reddish orange; pleura dark, with a longitudinal, light yellow stripe; knobs of halteres yellow; legs yellowish brown, without femoral rings; wings cream-yellow, with conspicuous pale brown clouds and washes; Sc_1 ending a short distance before the origin of Rs; male hypopygium with two dististyles, the outer a powerful chitinized rod, its tip bifid.

Male.—Length, about 2.5 millimeters; wing, 2.5.

Female.—Length, about 4 millimeters; wing, 3.5.

Rostrum and palpi black. Antennæ with the basal segments reddish orange, the flagellum black. Head pale yellow, the center of the vertex darkened.

[2] Rec. Indian Mus. 26 (1924) 301.

Pronotum and anterior lateral pretergites light yellow. Mesonotal præscutum brown with a faint grayish bloom; humeral region restrictedly obscure yellow, the pseudosutural foveæ reddish brown; females with a capillary darker brown median line on præscutum; scutal lobes dark brown, the median area and restricted caudal-lateral angles of the lobes yellow; scutellum yellow with a conspicuous brown median spot; postnotal mediotergite brown, the cephalic-lateral portions more yellowish. Pleura dark brown, with a longitudinal, light yellow stripe that is bordered both above and below by scarcely apparent blackish darkenings. Halteres dusky, the knobs yellow. Legs with the fore coxæ light yellow, the remaining coxæ brownish testaceous, trochanters obscure yellow; remainder of legs pale yellowish brown, unvariegated, the outer tarsal segments darker brown. Wings (Plate 1, fig. 20) cream-yellow, with conspicuous pale brown clouds and washes, including a major area in cell R before Rs; the cord and outer end of cell 1st M_2; conspicuous longitudinal seams along veins Cu as far as m-cu, cell Cu at base and along vein 1st A for more than one-half the length; axilla infumed; stigmal region scarcely darkened; veins pale yellow, very indistinct, more darkened in the clouded areas. Venation: Sc_1 ending shortly before the origin of Rs, Sc_2 near its tip; Rs strongly arcuated; anterior branch of Rs nearly straight; cell 1st M_2 closed; m-cu a short distance before the fork of M.

Abdominal tergites light brown, the anterior-lateral margins light yellow, the more extensive posterior-lateral margins velvety black; sternites more uniformly darkened; hypopygium brownish yellow. In female, the tergites blackened, with a restricted yellow area at each cephalic-lateral angle. Male hypopygium (Plate 3, fig. 40) with only two dististyles, the outer, *od,* a powerful chitinized rod, the stem straight, the head more enlarged and bifid, the more slender arm fingerlike, the other arm flattened, terminating in a comb of microscopic teeth; inner margin of stem with a row of powerful fasciculate setæ. Inner dististyle a small pale blade, the tip obtuse. Phallosome, *p,* complex.

LUZON, Laguna Province, Ube, February 11 to March 3, 1930 (*McGregor and Rivera*); holotype, male; allotype, female; paratypes, 2 females.

Gonomyia (*Lipophleps*) *secreta* by Edward's key to the species of the subgenus [3] runs to *G.* (*L.*) *robinsoni* Edwards (Malay States), a very different fly.

[3] Journ. Fed. Malay St. Mus. 14 (1928) 104–105.

GONOMYIA (PTILOSTENA) PUNCTIPENNIS Edwards.

Gonomyia (*Ptilostena*) *punctipennis* EDWARDS, Treubia 7 (1926) 140–141.

A few of both sexes, Lawa, Davao district, Mindanao, taken at trap lantern, May 5, 1930, by Charles F. Clagg. The species was described from Buru and will probably be found to be a widely distributed species in the Malayan and Moluccan islands.

TEUCHOLABIS (TEUCHOLABIS) MAJUSCULA sp. nov. Plate 1, fig. 21; Plate 3, fig. 41.

General coloration yellow and black; præscutal stripes confluent; pleura black, striped longitudinally with yellow; knobs of halteres obscure orange; legs entirely black; wings yellow, the outer radial cells slightly infumed; male hypopygium with the outer dististyle a macelike capitate structure.

Male.—Length, about 9 millimeters; wing, 8.

Rostrum nearly as long as remainder of head, black; palpi black. Antennæ black throughout; basal flagellar segments short-oval, becoming smaller and more elongate outwardly. Head black, the front and wide anterior vertex sparsely dusted with gray.

Pronotum very large, yellow. Mesonotal præscutum chiefly occupied by three confluent polished black stripes, leaving yellow areas at the humeri, a transverse median area at the suture and a tiny spot at each posterior-lateral angle; scutum yellow, each lobe chiefly covered by polished black centers; scutellum deep yellow; postnotal mediotergite yellow on cephalic third, the remainder black. Pleura black, with a conspicuous yellow longitudinal stripe that extends from behind the fore coxæ, passing beneath the halteres to the abdomen; dorsopleural region yellow. Halteres dusky, the knobs obscure orange. Legs with the fore coxæ reddish, the remaining coxæ and all trochanters black; remainder of legs entirely black. Wings (Plate 1, fig. 21) with a strong yellow tinge, the outer radial cells slightly more infumed; anterior prearcular cells infuscated; veins black. Venation: Sc long, Sc_1 ending about opposite four-fifths the length of Rs, Sc_2 at near midlength of this vein; R_1 in alignment with R_{1+2}; cell 1st M_2 elongate, parallel-sided; m-cu more than its own length beyond the fork of M.

Abdomen bicolorous, black, the incisures more narrowly orange, on the tergites this color wider on the caudal margins than on the bases of the segments. Male hypopygium (Plate 3, fig. 41) with the tergal region narrowly emarginate medially; sternite, 9*s*, convexly rounded, with abundant setæ, especially on

sides. Basistyle, *b*, with the dorsal-apical angle produced into a black spine; the ventromesal angle with irregular blackened teeth. Outer dististyle, *od*, a mace-shaped structure, as figured. Inner dististyle, *id* longer, the basal half wider, the distal half gradually narrower and angularly bent, with three setæ at the angulations, the apex an acute black spine. Phallosome, *p*, with a wider dorsal and a narrow ventral plate, both tipped with long conspicuous setæ.

MINDANAO, Davao district, Lawa, April 18, 1930, at trap lantern (*Clagg*); holotype, male.

Teucholabis (*Teucholabis*) *majuscula* is one of the largest species of the genus, though exceeded in size by the allied *T.* (*T.*) *nigerrima* Edwards (Formosa). Both of these species have R_1 in alignment with R_{1+2}, the veins not dipping slightly caudad at the point of union with R_2 as is the case in virtually all other species of this extensive genus.

TEUCHOLABIS (TEUCHOLABIS) CONFLUENTOIDES sp. nov. Plate 1, fig. 22; Plate 3, figs. 42 and 43.

Male.—Length, about 6.5 to 7 millimeters; wing, 6 to 6.5. Generally similar to *T.* (*T.*) *confluenta* Alexander (Luzon), differing especially in the structure of the male hypopygium and the details of venation.

Pronotum extensively pale yellow. Mesonotal præscutum black, the humeral triangles extensively and conspicuously light yellow; scutal lobes blackened, the median region broadly yellow, crossing the suture onto the præscutum. Dorsopleural region clearer yellow. Wings (Plate 1, fig. 22) with the pattern banded, much as in *confluenta*. Venation: Cell 2d M_2 much deeper, exceeding its petiole. Male hypopygium (Plate 3, fig. 42) with the spine of the basistyle, *b*, simple. Outer dististyle, *od*, with two, or in cases, a minute third, spine, in addition to the long curved apex. Inner dististyle, *id*, with a bisetose lobe at base and on obtuse lobule in addition to the long spinous point.

In *confluenta* (Plate 3, fig. 43) the spine of the basistyle, *b*, is forked. Outer dististyle, *od*, a long sinuous rod, with a single small spine at near midlength. Inner dististyle, *id*, a simple black rod.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 to 5,800 feet, July 2 to 3, 1930 (*Clagg*); holotype, male; paratypes, 4 males. "Dancing above ferns in semitwilight of dense mossy forest."—Clagg.

ILLUSTRATIONS

[Legend: *a*, ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbasal process; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *s*, 9th sternite; *t*, 9th tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Limonia* (*Limonia*) *candidella* sp. nov., wing.
2. *Limonia* (*Limonia*) *latiflava* sp. nov., wing.
3. *Limonia* (*Limonia*) *flavohumeralis* sp. nov., wing.
4. *Limonia* (*Limonia*) *canis* sp. nov., wing.
5. *Limonia* (*Rhipidia*) *luteipleuralis* sp. nov., wing.
6. *Limonia* (*Geranomyia*) *phœnosoma* sp. nov., wing.
7. *Limonia* (*Geranomyia*) *longifimbriata* sp. nov., wing.
8. *Limonia* (*Geranomyia*) *paramanca* sp. nov., wing.
9. *Limonia* (*Pseudoglochina*) *angustapicalis* sp. nov., wing.
10. *Limonia* (*Alexandriaria*) *sollicita* sp. nov., wing.
11. *Orimarga* (*Orimarga*) *rubricolor* sp. nov., wing.
12. *Epiphragma* (*Polyphragma*) *bakeri* Alexander, wing.
13. *Epiphragma* (*Polyphragma*) *parviloba* sp. nov., wing.
14. *Limnophila* (*Ephelia*) *igorota* sp. nov., wing.
15. *Pilaria phœnosoma* sp. nov., wing.
16. *Pilaria carbonipes* sp. nov., wing.
17. *Gonomyia* (*Lipophleps*) *maquilingia* sp. nov., wing.
18. *Gonomyia* (*Lipophleps*) *pallidisignata* sp. nov., wing.
19. *Gonomyia* (*Lipophleps*) *alboannulata* sp. nov., wing.
20. *Gonomyia* (*Lipophleps*) *secreta* sp. nov., wing.
21. *Teucholabis* (*Teucholabis*) *majuscula* sp. nov., wing.
22. *Teucholabis* (*Teucholabis*) *confluentoides* sp. nov., wing.

PLATE 2

FIG. 23. *Scamboneura nigrotergata* sp. nov., male hypopygium, details.
24. *Scamboneura calianensis* sp. nov., male hypopygium, ninth tergite.
25. *Scamboneura calianensis* sp. nov., male hypopygium, outer dististyle.
26. *Limonia* (*Limonia*) *candidella* sp. nov., male hypopygium.
27. *Limonia* (*Limonia*) *flavohumeralis* sp. nov., male hypopygium.
28. *Limonia* (*Limonia*) *canis* sp. nov., male hypopygium.
29. *Limonia* (*Geranomyia*) *phœnosoma* sp. nov., male hypopygium.
30. *Limonia* (*Geranomyia*) *longifimbriata* sp. nov., male hypopygium.
31. *Limonia* (*Pseudoglochina*) *angustapicalis* sp. nov., male hypopygium.
32. *Epiphragma* (*Polyphragma*) *bakeri* Alexander, male hypopygium.
33. *Epiphragma* (*Polyphragma*) *parviloba* sp. nov., male hypopygium.

PLATE 3

FIG. 34. *Limnophila* (*Ephelia*) *igorota* sp. nov., male hypopygium, outer dististyle.

35. *Pilaria phœnosoma* sp. nov., male hypopygium.

36. *Gonomyia* (*Lipophleps*) *maquilingia* sp. nov., male hypopygium.

37. *Gonomyia* (*Lipophleps*) *pallidisignata* sp. nov., male hypopygium.

38. *Gonomyia* (*Lipophleps*) *alboannulata* sp. nov., male hypopygium.

39. *Gonomyia* (*Lipophleps*) *luteimarginata* sp. nov., male hypopygium.

40. *Gonomyia* (*Lipophleps*) *secreta* sp. nov., male hypopygium.

41. *Teucholabis* (*Teucholabis*) *majuscula* sp. nov., male hypopygium.

42. *Teucholabis* (*Teucholabis*) *confluentoides* sp. nov., male hypopygium.

43. *Teucholabis* (*Teucholabis*) *confluenta* Alexander, male hypopygium.

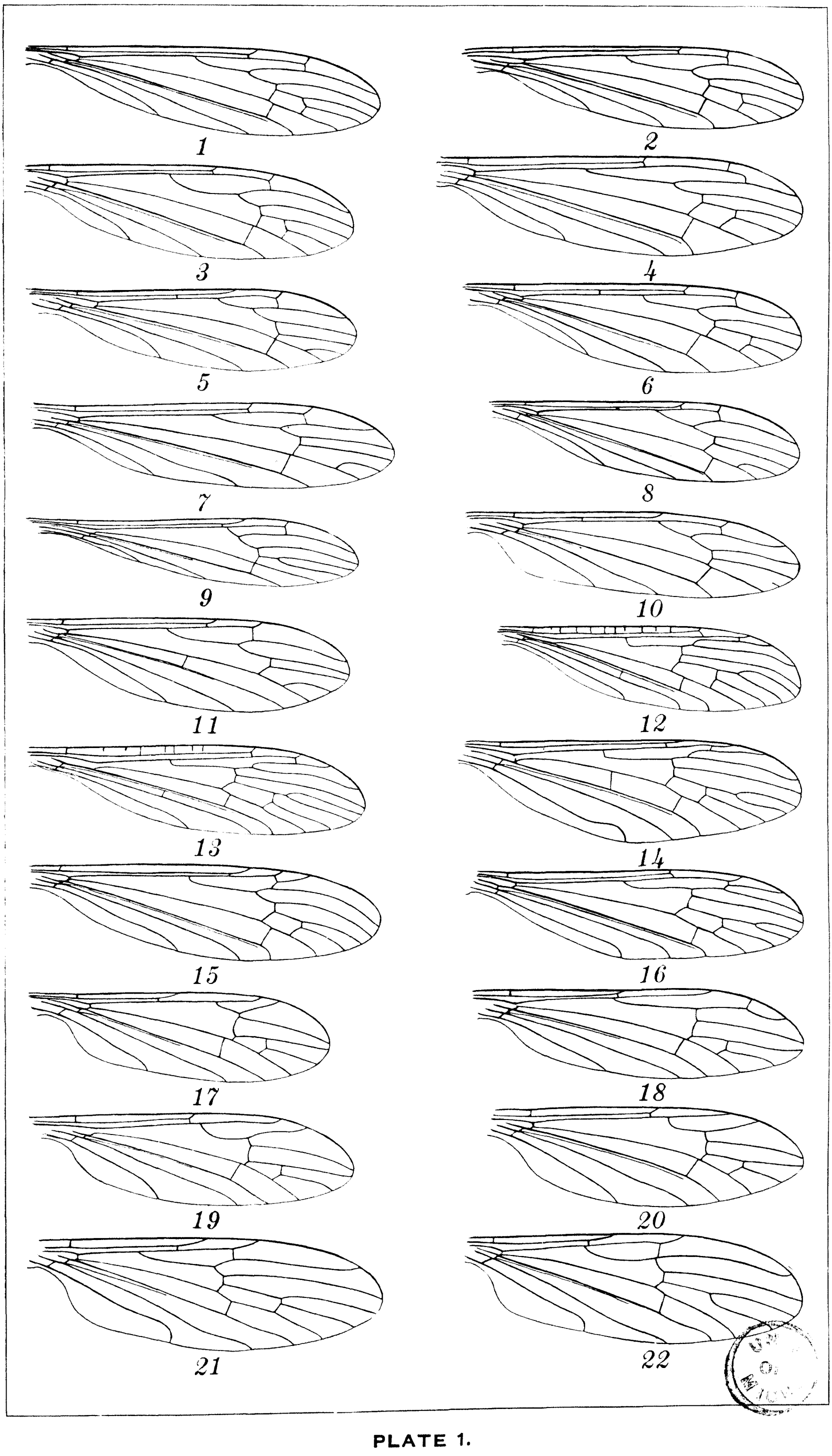

PLATE 1.

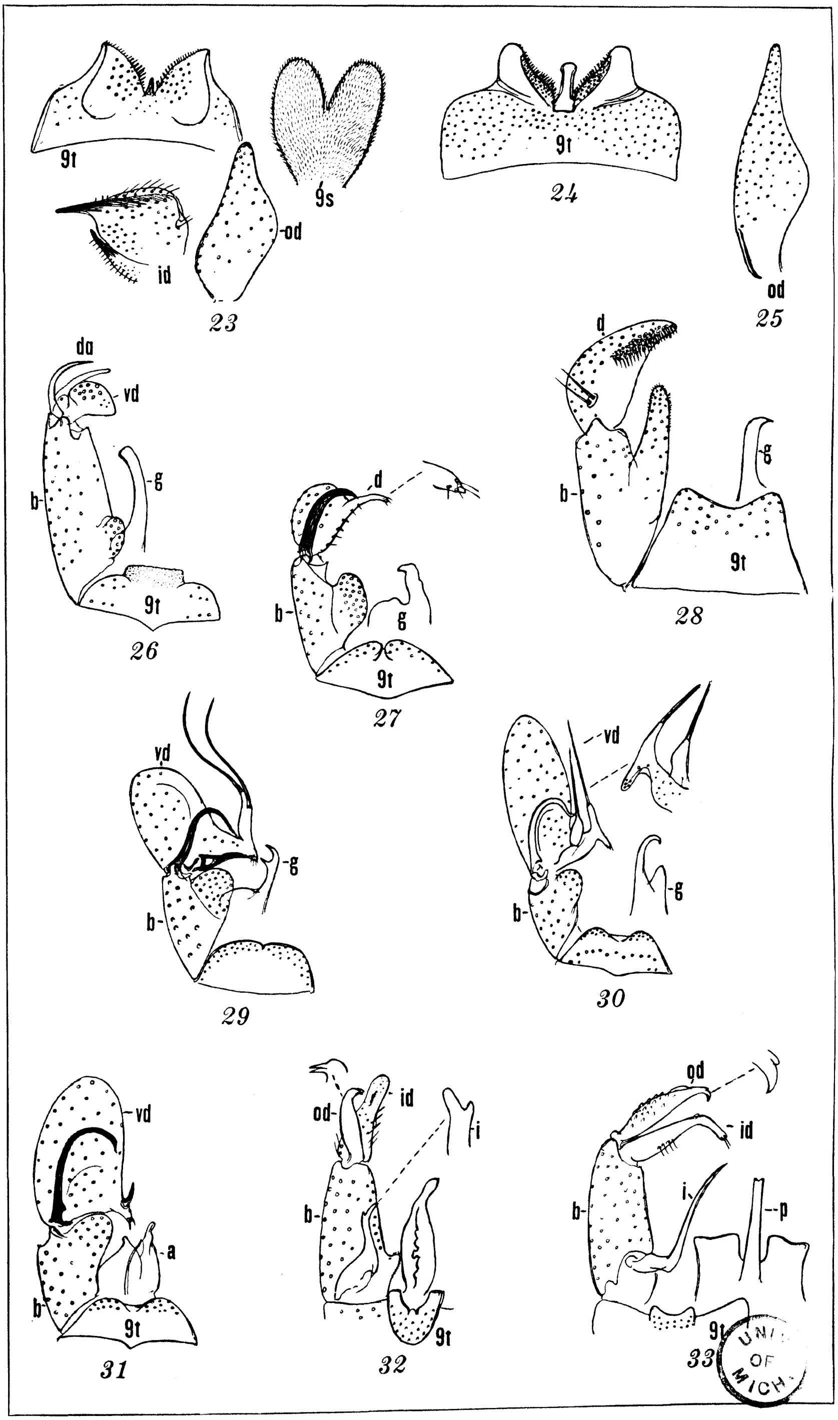
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PLATE 2.

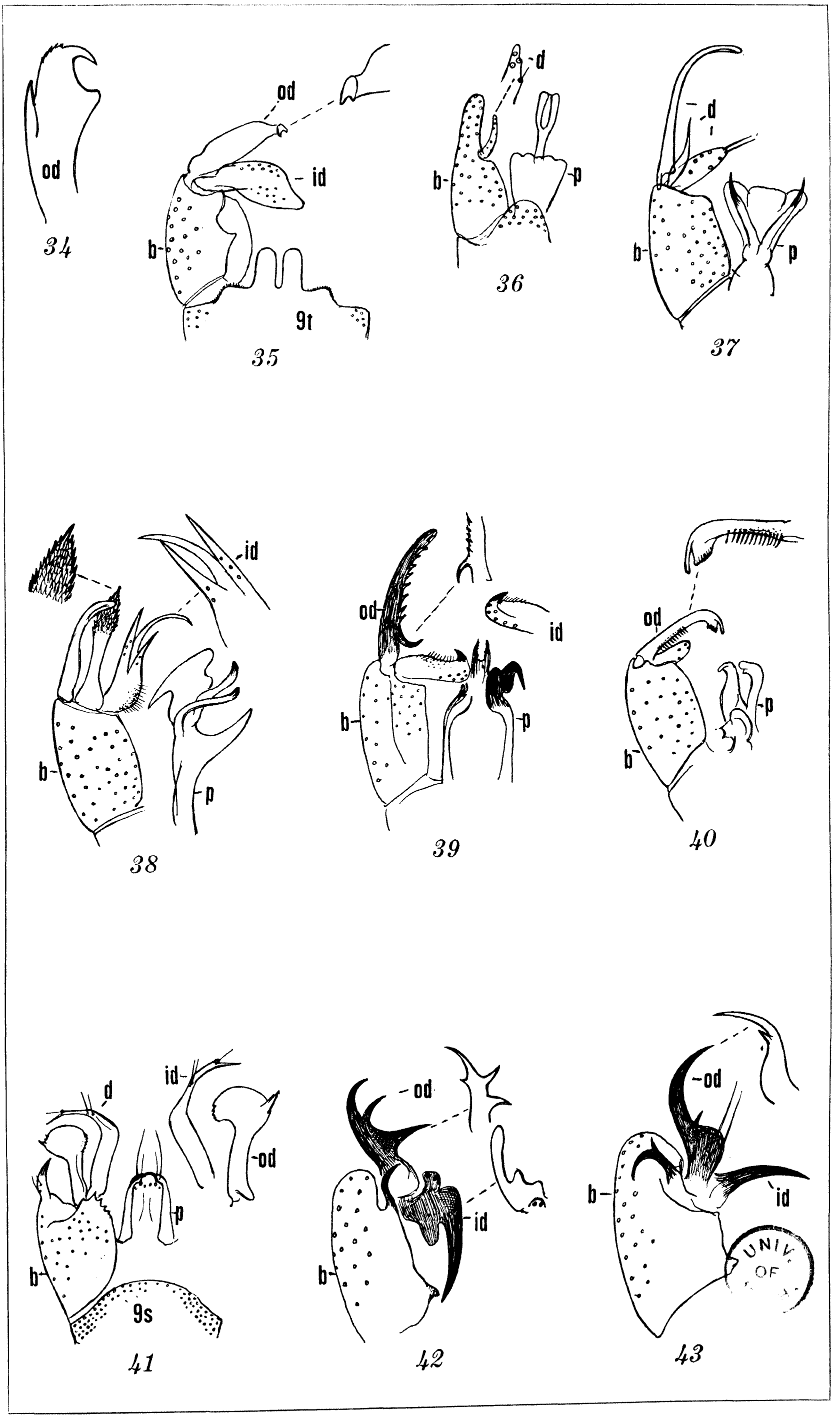
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PLATE 3.

ORIGIN OF THE IRRITATING SUBSTANCE IN MOSQUITO BITE [1]

By C. MANALANG

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ONE PLATE

Ludlow [2] mentioned the properties of the salivary-gland secretion among the problems concerning malarial infection of mosquitoes that need further investigation. She said:

> As far as I am aware, nobody has yet repeated Schaudinn's observations. He states that the salivary gland rubbed into an abrasion does not produce the irritation of mosquito bite, but that, on the contrary, if the œsophageal diverticula be rubbed in, the well known itching effects are experienced, which he attributes to the enzymes produced by low bacterial forms in the diverticula. Any facts established about mosquitoes is of value, for we never know to what practical purposes such knowledge may not be turned.

Castellani and Chalmers [3] said:

> There has been much dispute as to where this substance comes from, but this appears to have been settled by Schaudinn who triturated the isolated salivary glands in salt solution which he applied to a wound with negative results. On the other hand when he applied the isolated œsophageal diverticula to a scratch he obtained the characteristic irritation and redness. These œsophageal diverticula contain gas bubbles and bacteria or moulds. The bubbles were shown by Schaudinn to contain carbon dioxide by applying baryta-water to the diverticula, when a precipitate was obtained. The fungi need further investigation, but they or their products appear to be the real cause of irritation, for when Schaudinn expressed the carbon dioxide out of the sac the signs characteristic of the bite were still produced.

While dissecting anopheline mosquitoes for malarial parasites, I applied isolated glands to five separate needle scratches on the anterior surface of my forearm. In a few seconds I experienced itching, followed by the appearance of wheals around

[1] From the field laboratory of the division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan.

[2] Surgeon General, U. S. Army, Bull. 4 (1913) 90.

[3] Manual of Tropical Medicine 3d ed. (1919) 224–225.

the edges of the scratches, then by a distinct redness of the surrounding skin in all the scratches. I repeated the test, using isolated gas-containing diverticula. Of the four trials, one scratch itched slightly, followed by a small area of redness around the scratch. The other three scratches did not show any reaction at all. With results unlike those of Schaudinn's, I repeated the experiment using more material and two methods (scratch and prick) of inoculation.

Most of the mosquitoes used were *Anopheles ludlowi* Theobald and *A. vagus* Donitz, which were the dominant species in the catches at the time. *Anopheles maculatus* Theobald, *A. aconitus* var. *filipinæ* Manalang, *Culex quinquefasciatus* Say, *Aëdes ægypti* Linnæus, a *Culex* species, four male *A. ludlowi,* and one male *C. quinquefasciatus* were also used.

The scratch method of inoculation seems to have the disadvantage of drawing blood, which may dilute or prevent the inoculum from penetrating the tissues. Light scratches may not be sufficient to permit its penetration. They may dry up in case of any delay in the inoculation. The prick on the other hand is more like the natural bite. With magnifying-lens control the inoculum can be picked up at the point of the needle. This facilitates the entrance of the inoculum at the first prick, or, if it fails and the inoculum is left on the skin, subsequent pricks (about twenty) on the same spot will succeed.

METHODS AND RESULTS

Scratch method.—The freshly killed mosquito is dissected in a drop of normal saline under a magnifying lens. Once the salivary gland and diverticulum are isolated a series of three shallow scratches, about 0.5 centimeter long and 2 centimeters apart, are made with a few strokes of a pointed needle on the anterior surface of the forearm. This surface is used because the reaction is clear, the skin being thinner and lighter in color than that on the posterior surface. With the aid of the magnifying lens the gland (usually three lobes from one side) is picked up with the needle and very lightly rubbed several times into one scratch. Wash the needle in saline, wipe dry, and repeat the process with the diverticulum (usually the abdominal) on the other scratch. The third or control scratch is inoculated with a minute quantity of salt solution from the same drop in which the mosquito has been dissected. This is done to detect any soluble substance from any organ which may give a re-

action. The results of the tests by this method are set forth in Table 1.

TABLE 1.—*Scratch tests.*

Organ tested.	Number of tests.	Positive.	Slightly positive.	Negative.
Salivary gland (from females)	30	30		
Salivary gland (from males)	2			2
Diverticulum	7	1	2	4
Stomach	4	1	1	2
Ova	1	1		
Malphigian tubes	1		1	
Parasites	1		1	
Control	10			10

Prick method.—After isolation, the organ to be tested is picked up on the point of the needle, then inoculated by twenty light pricks on a fixed point on the skin. I usually select the root of a hair or the edge of an ink mark. The prick should be just felt but not deep enough to draw blood. The results by this method are set forth in Table 2.

TABLE 2.—*Prick tests.*

Organ tested.	Number of tests.	Positive.	Slightly positive.	Negative.
Salivary gland (from females)	18	18		
Salivary gland (from males)	2		1	1
Diverticulum (from females)	10	9	1	
Diverticulum (from males)	3	3		
Stomach (females)	5	2	3	
Malphigian tubes	6	1	5	
Thoracic muscle	1			1
Testes	2	1		1
Œsophagus	1	1		
Ova	2	1	1	
Wing	2			2
Stomach (from males)	2	1	1	
Eye	1		1	
Parasite	1	1		
Brain	1			1
Control	12			12

A typical reaction starts with itching immediately followed by the appearance of a wheal, which enlarges and rises with increasing paleness in contrast with the spreading redness of the surrounding skin. The height of reaction is reached at the moment the wheal begins to lose its pallor and turn red. A small red indurated area persists at the point of inoculation

six to twenty-four hours after a positive test, depending on the individual's susceptibility. A positive reaction is apparently more rapid and intense on a perspiring skin than on a dry one. The reaction is less intense or only slight when the scratch or puncture is deep and draws blood. It seems, therefore, that the wheal is due to the entrance of the irritating substance into the lymphatics in the corium and not in the deeper tissues. A negative reaction is without itch or wheal. There is only a redness of the scratch or puncture as the case may be. A slightly positive reaction produces less itching, a small wheal, and an area of redness.

All the forty-eight tests with salivary glands from female mosquitoes (thirty by scratch and eighteen by prick) gave positive reactions. It will be noted that with the scratch method, out of seven diverticula tested only one gave a positive reaction and two slight reactions, while with the prick method the thirteen diverticula (from both sexes) all gave typical positive reactions, except one, which gave a slight reaction. The failure of most diverticula to react by the scratch method was due to a deep scratch, to bleeding, to a very shallow scratch, or to a long interval of time that allowed the serum to dry up between the time of the scratch and the time the diverticulum was inoculated. It was often difficult to pick up a diverticulum heavily loaded with gas bubbles.

OTHER OBSERVATIONS

(*a*) Salivary glands from five female anophelines were allowed to dry on a slide at room temperature (25 to 35° C.) from three to five days. Upon inoculation with a little salt solution, they all produced positive reactions.

(*b*) Diverticula with gas, or with the gas pressed out, gave identical reactions. No difference was noted between the reaction of the abdominal diverticulum and that of the thoracic diverticulum. Diverticulum from the male gave the same reaction as that from the female.

(*c*) Fresh or dried salivary gland rubbed into unabraded skin produced no reaction.

(*d*) Inoculation by prick of one, two, and three lobes of salivary gland from one mosquito produced the smallest wheal with one lobe, and the largest with three lobes. In a repetition of this test the two-lobe inoculum gave the largest wheal.

(*e*) Six individuals were each inoculated twice in an identical manner (prick) with salivary glands from different mosquitoes.

One of them constantly gave a marked reaction with large wheals and areas of redness, two with lesser, and three with slight itching, and tiny wheals and transitory redness around the points of inoculation. Using diverticula, they showed the same varying degrees of reaction obtained with the salivary glands.

(*f*) The reactions obtained from *Anopheles, Culex,* or *Aëdes* showed no difference on comparison.

(*g*) The salivary glands of the male were always much smaller, slenderer, and more fragile than those of the female. This probably accounts for the failure to obtain a good positive reaction for this sex.

(*h*) The parasites, (Sporozoa or fungus, probably not microsporidia) which were not infrequently found in clumps at the base of the salivary glands, gave a typical bite reaction in one test and a slight reaction in another. In the fresh state they appeared as irregular or spherical granular bodies containing a variable number of very refractile "cysts." Under a high magnification, these "cysts" were surrounded by colorless, black, and bluish granules. Stained with Heidenhain's, the parasites were about the size and appearance of amœbæ with vacuoles. Throughout the tests only salivary glands free from these parasites were used. They were not found on the stomach or diverticulum.

(*i*) Positive reactions were observed in a certain number of stomachs, malphigian tubes, œsophaguses, ova, testes, etc.

SUMMARY AND CONCLUSIONS

1. The salivary gland of the mosquito inoculated into the skin produced a typical bite reaction, contrary to Schaudinn's finding.
2. Schaudinn's reaction using the diverticulum was confirmed by the prick method in ten tests with the diverticula from the female mosquito and in three tests with those from the male.
3. The irritation of mosquito bite must, therefore, be due to injection of the salivary-gland secretion or diverticular contents, or both, and not to diverticular origin only.
4. Typical bite reactions were also obtained from parasites (Sporozoa or fungus) and from the other organs; such as, stomach, œsophagus, testes, and ova.
5. Different degrees of susceptibility to the bite were tested and demonstrated in six individuals.

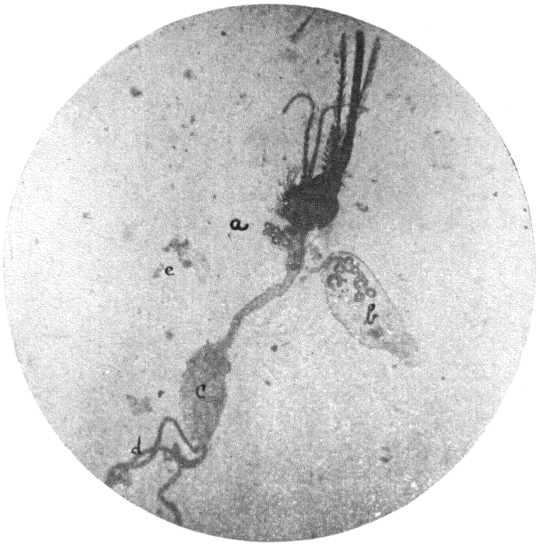
ILLUSTRATIONS

[Microphotographs by C. M. Urbino, Philippine Health Service.]

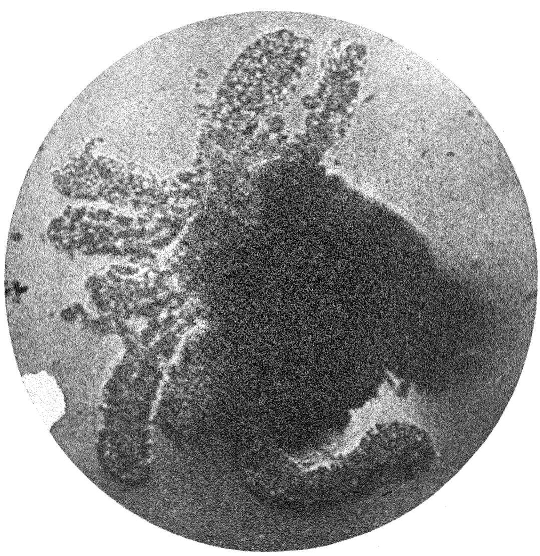
PLATE 1

FIG. 1. *a*, Thoracic diverticulum with gas; *b*, abdominal diverticulum with gas; *c*, stomach; *d*, Malphigian tubes; *e*, two detached lobes of the salivary gland; about × 55.

2. Salivary gland from *A. vagus* Donitz with eight lobes and a cluster of parasites at the base; about × 160.



1



2

PLATE 1.

MALARIA TRANSMISSION IN THE PHILIPPINES, III [1]

DENSITY AND INFECTIVE DENSITY OF ANOPHELES FUNESTUS GILES

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The present paper is a continuation of the preceding two articles and is based on certain data compiled from observations that began in September, 1927, in La Mesa camp of the Novaliches water project and extended during the following two years to seven other camps and two barrios far from, and independent of, the project. An attempt will be made to show the significance of density in the transmission of malaria without considering the suitable human-carrier factors. About 22,000 *Anopheles funestus* Giles were caught, mostly by trapping, and were dissected. With these were 298 infected mosquitoes found in six out of ten places, as follows: In South Portal camp 218 positive mosquitoes were caught; in North Portal, 26; in La Mesa, 32; in Atlantic, Gulf, and Pacific Company camp, 13; in Tungkong Manga, 7; and in San Francisco del Monte, 2 (oöcysts only). No positive mosquitoes were caught in Novaliches Barrio, Bigti, Santo Cristo, or Alinsangan camps.

The traps used were of standard dimensions and the time employed by the catcher was practically the same in all areas. Approximately the same number of hours was also used in catching mosquitoes without traps. The densities obtained through these collections are only approximate, but the duration and regularity of observation are considered sufficiently adequate to counterbalance the errors.

The appended tables give the catches of *A. funestus* in all areas with the results of dissection, densities for the positive and negative months, and densities in four negative places. Infective (sporozoite rate) densities are expressed as one for every so many mosquitoes dissected by individual months and as monthly averages during each year. Table 7 is a summary

[1] From the field laboratory, division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan.

of findings in five places, by years, where sporozoites were discovered, giving the average monthly and infective densities by years, and the average densities for negative months, if any, to compare with the average densities of positive months. Table 6 shows the catches in four areas where no infected *funestus* were found.

TABLE 1.—*Catches and findings in South Portal.*

Year and month.	Number caught.	Positives.			Infective (sporozoite) density. One in—
		Stomach.	Salivary gland.	Total infected.	
1927					
December	234	6	2	8	177
1928					
January	723	9	4	13	181
February	201	3	3	6	67
March	567	7	6	13	95
April	498	3	8	11	62
May	562	16	17	33	33
June	469	6	11	17	43
July	735	23	10	33	73
August	490	16	7	23	70
September	371	8	7	15	53
October	671	9	2	11	335
November	255	3	2	5	127
December	223	4	6	10	37
Total	5,765	107	83	190	
Average catch per positive month (density), 1928	480				
Average monthly infective density					[a] 69
1929					
January	93		1	1	93
February	65	2		2	
March	90	3	4	7	23
April	170	1	1	2	170
May	124	2	2	4	62
June	313	2		2	
July	148				
August	81	1		1	
September	43				
October	29				
November	47				
December	57	1		1	
Total	[b] 993	12	8	20	
Average catch per positive month (density), 1929	124				
Average catch per negative month (density)	67				
Average monthly infective density					[a] 124

[a] Computed on catches during positive (stomach and salivary gland) months only.

[b] Positive months only. December, 1927, to February, 1928, inclusive, by exposure. Trap used since March, 1928.

COMMENTS

South Portal (Table 1) was by far the most malarious (more transmission) of the six places, judging by the mosquito infection. In this camp, the year 1928 was more malarious than 1929, there having been not only more *funestus* but fewer bites were necessary for infection. The average monthly density and the infective density were 480, and 1 in 69, respectively, in 1928, as compared with 124, and 1 in 124, respectively, in 1929. Within the average twenty-three catching days per month, the susceptible human bait in the trap had seven chances monthly of becoming infected if all the mosquitoes bit him, or an average of almost one infective bite every three days during 1928. In 1929, his chance was one infective bite in twenty-three days; in December, 1927, two infective bites in twenty-three days.

At North Portal (Table 2) with its monthly density of 412, and infective density of 1 in 515, in 1928, it would have required the bites of all the mosquitoes coming into the trap for twenty-nine days to assure an infective one being included, while in 1929, with 833, and 1 in 1,250, as monthly and infective densities, respectively, it would have required thirty-five days before infection could have been received.

La Mesa (Table 3) was more malarious in 1928 than in 1927, in spite of a larger number (more than three times) of *funestus* in 1927. The infective density of 1 in 400 and the monthly density of 500 in 1927 would only give a little over one infective bite during twenty-three catching days, while the lower density of 120 in 1928 would give more than two infective bites (the infective density being 1 in 52). The duration of observations in the other places does not permit comparison of infection of one year with another, but a comparison of one place with another shows again the rôle of density in the amount of malaria transmission.

In 1929, the average density during the positive months (January to May) in Tungkong Manga was 846 for a month of twenty-three catching days. The infective density was 1 in 1,411, so that it would have required an exposure of thirty-nine days before an infective bite could have been received. This is in accord with James's [2] statement that "numerous anophelines

[2] Malaria at Home and Abroad. John Bale, Sons and Danielsson, Ltd., London (1920) 13.

TABLE 2.—*Catches and findings in North Portal.*

Year and month.	Number caught.	Positives. Stomach.	Positives. Salivary gland.	Positives. Total infected.	Infective (sporozoite) density. One in—
1927					
December	8	1		1	
1928					
January	30	3		3	
February	105				
March	0				
April	0				
May	7				
June	0				
July	0				
August	0				
September	110		1	1	110
October	939	12	2	14	469
November	209	1		1	
December	771	1	1	2	771
Total	[a] 2,059	17	4	21	
Average catch per positive month (density)	412				
Average catch per negative month (density)	56				
Average monthly infective density					[b] 515
1929					
January	1,307	1	1	2	1,307
February	620	1		1	
March	572		1	1	572
April	366				
May	68				
June	46				
July	26				
August	10				
September	5				
Total	[a] 2,499	2	2	4	
Average catch per positive month (density)	833				
Average catch per negative month (density)	87				
Average monthly infective density					[b] 1,250

[a] Positive months only.
[b] Based on total catches in positive months. Trap used since September, 1928.

of a species which is an efficient carrier are associated with little or no malaria," and with Gill's [3] reference to "anopheles *sine* malaria, one instance of which is the large measure of 'control,' achieved over malaria in Italy by the method of 'bonification' in spite of the fact that this measure has actually led, in some instances, to increased prevalence of anophelines." Had the density in Tungkong Manga prevailed in La Mesa (com-

[3] Trans. 7th Cong. Far Eastern Assoc. Trop. Med. 2 (1927) 630.

TABLE 3.—*Catches and findings in La Mesa.*

Year and month.	Number caught.	Positives.			Infective (sporozoite) density. One in—
		Stomach.	Salivary gland.	Total infected.	
1927					
September	669		1	1	669
October	473	3		3	
November	512	4	4	8	128
December	346	6		6	
Total	2,000	13	5	18	
Average catch per month	500				
Average monthly infective density					400
1928					
January	116	1	3	4	39
February	61				
March	227	5	4	9	57
April	0				
May	7				
June	0				
July	0				
August	0				
September	18	1		1	
Total	[a] 361	7	7	14	
Average catch per positive month (density)	120				
Average catch per negative month (density)	34				
Average monthly infective density	52				

[a] Positive months only. Catches by exposure.

pare with May, 1928, South Portal) during January, February, March, and April, 1928, with an infective density of 1 in 52, the rate would have meant sixteen infections in twenty-three days; in which case only a little over one day of exposure would have been required to cause one infection. This would have resulted in an explosive epidemic that would probably have disappeared rapidly from May till October (average density 6 per month). Conversely, had the monthly infective density of Tungkong Manga, 1 in 1,411, occurred in La Mesa, with its monthly density of 120, it would have required two hundred eighty-one days of exposure before a positive bite could have been contracted, so that there would have been no malaria at all in the locality (compare with 1929, Tungkong Manga).

The fluctuation of individual monthly density and the corresponding infective number (the latter due to the number of suitable human carriers, whose movements and accessibility to the vector could not possibly be under control) is interesting

TABLE 4.—*Catches and findings in San Francisco del Monte.*

Year and month.	Number caught.	Positives.		
		Stomach.	Salivary gland.	Total infected.
1928				
June	2			
July	1			
August	5			
September	32			
October	108	2		2
November	69			
December	80			
Total	[a] 108	2		2
Average catch per positive month (density)	108			
Average catch per negative month (density)	32			
1929				
January	108			
February	29			
March	4			
April	8			
May				
June				
July	1			
August	1			
Total	151			
Average monthly catch (density)	25			

[a] Positive month only (October). Trap used from September, 1928.

and explains how easily a person may contract the disease during a very short visit to a malarious place. Take, for example, South Portal in May, 1928, when a trap density of 562 with an infective density of 1 in 33 was capable of seventeen infective bites in twenty-three catching days. During the month, one could easily have contracted the disease in a little over one night's sleep in the camp. Yet, in terms of the infection rate, the usual way of expressing malaria in numbers of mosquitoes, only 3 per cent of them had sporozoites in their salivary glands capable, at the time, of transmitting the disease; certainly a low figure by itself if one is to receive only one bite. But since, in nature, an exposed individual receives several or many bites during a single night, his chances of infection must rise in proportion to the number of bites he receives. To produce an infection for example, thirty-three individual mosquito bites would not be too many or too noticeable a number to be received in, say, two nights during slumber. The percentage

method of expressing malaria in mosquitoes seems to have led experienced students to explain the very high incidence of malaria in man by assuming that the vector bites only in the house, and that once infected it stays in the same house, or that if it leaves it usually returns, or by the findings (experimental or epidemiological) that an infective anopheline can infect several people in one night or many in several consecutive nights (James).[4] A similar argument was put forth by Swellengrebel[5] of the Malaria Commission of the League of Nations in the discussion of the subject, "Where does *A. maculipennis* infect man?" to prove that it (*maculipennis*) bites in the house and not in the open. He says,

> Even under extremely favourable conditions, the number of infected *A. maculipennis* is so small that the chances of being infected by anopheles in the open seem to be infinitesimal, even if this insect were in the habit of biting in the open, which is generally supposed not to be the case. On the other hand, if we suppose that at least a portion of the anophelines regularly visiting houses remain there sufficiently long to become infective after having become infected with malaria parasites, this would explain not only human infections, even with a small parasite index among the anophelines but also the house infection so often observed. This house infection can hardly be explained by random infection.

. . . His figures showing the greater prevalence of infective mosquitoes in the houses as compared with the stables to prove his contention are as follows:

> In winter (Sella in Fumicino: October-December, 1918, 3.8–4.6 per cent infected in houses, 0.49–0.85 per cent in stables); (Swellengrebel, Amsterdam, October-December, 1920, 4.99 per cent infected in houses, 0.66 per cent in stables). But in summer this may be different (Sella, June-September, 1919, 0.5–3.3 per cent in houses; 0.27–2.00 per cent in stables).

These figures are not significant, unless it is possible to show that the stable rates of infection were based only on the numbers of *maculipennis* actually concerned in the malaria transmission in man, but resting in the stable, and that the rates were not influenced by the numerous anophelines in the stable that fed solely on animals. A corrective factor based on precipitin test should have been mentioned. King[6] observed that a high mosquito density (575 bites during the season) offsets a low infec-

[4] See reference, footnote 2.

[5] Report on its tour of investigation in certain European countries in 1924. Geneva (March, 1925) 178.

[6] Southern Med. Journ. 17 (1924) 596–597.

tion rate (0.107 per cent) and accounts for the prevalence of malaria. It is believed that a study of the densities and infective densities in different sections or in houses of a locality over an adequate period of time will explain house infection more satisfactorily, as only then can the theory of many human infections from a single mosquito (a rather difficult task to demonstrate directly in nature, particularly if the vector is wild, although understandable epidemiologically) be proved with reasonable scientific certainty. In his summary (p. 183), however, Swellengrebel said:

> The evidence that man is infected outside his habitations (in the wider sense of the word) is still insufficient, but strong enough to warrant further enquiry.

He mentioned that during their visit to Fumicino (p. 180) Grassi emphasized the discordance between the high malaria incidence and the low number of anophelines in the house and set forth the following practical question:

> If the number of anophelines in the immediate surrounding of man has so little to do with the incidence of malaria, is this not an indication that if once anophelines are present in a certain minimum quantity, other factors influencing the incidence of malaria tend to become of such predominating importance that it matters little whether the initial number of anophelines is maintained or multiplied tenfold? If this, or anything like it, were true, any attempt to diminish the malaria-incidence by reduction of the number of anophelines will be useless, unless the reduction reaches this hypothetical minimum.

The last question is in accord with Ross [7] and explains the excellent results of Watson's antilarval measures in many of his projects in Malaya, the water-cistern control in Palestine, particularly Jerusalem, mosquito control in the United States, and Hackett's projects in Italy. It is also clear that an initial hypothetical anopheline density and infective density in one locality capable of inflicting an infective bite every two or three days (compare with May, 1928, South Portal) can be maintained or multiplied tenfold and still infect 100 per cent of the exposed and susceptible individuals within a short period of time because the number of new cases will appear rapidly and, therefore, outnumber the recoveries. But a density and infective density of one infective bite in one month as an initial minimum hypo-

[7] "That if the number of malaria-bearing *Anophelines* is below a certain figure that limit (fixed limit of malaria) is zero."—The Prevention of Malaria (1911) Sec. 28.

thetical number in another locality (Tungkong Manga, 1929), if only maintained, cannot possibly infect a large percentage of the people within a short time because the number of new cases are too few and far apart to outnumber the recoveries. To infect 100 per cent it would be necessary to multiply the initial density many times over.

The summaries given at the end of the present paper are believed sufficient answer to the practical question quoted from Swellengrebel. The hypothetical number must be, according to the data presented, not only variable in the same place at different periods, but must also differ in different localities, which accounts for the successes and failures of the mosquito-control measures that have always been the cause of misunderstanding between the Malaria Commission and the antimosquito enthusiasts, as evidenced in their conclusion written by Swellengrebel[8] (p. 189) as follows:

> Although during our tour we have seen many instances of anti-larval or anti-adult measures, there was not one of them in which the efficiency of the measure had been proved by its influence on the prevalence of malaria. This does not mean that there had not been such an influence, although in many instances this was probably so, but that the methods to collect the necessary statistical material had been inadequate.

On page 174 he says:

> We have tried to form a judgment on the effect of the anti-larval measures demonstrated to us, not by the reduction of the malaria rate (because (1) this reduction usually could not be demonstrated, owing to the absence of reliable statistical material; (2) it often coincided with a reduction in other places where no such measures were taken; (3) this measure was never taken without others, notably quininisations, the effect of the two being difficult to distinguish) but by the prevalence of larvæ in the breeding places and of adult anophelines in houses especially in stables.

In this instance the conclusion is unavoidable that the Malaria Commission of the League of Nations erred in undertaking to form a judgment (on the influence of antilarval measures in particular places where malaria has been reduced) based on the prevalence of larvæ in the breeding places and on adults in houses and stables at the time of their visit, when data on the prevalence of both larvæ and adults (which should have been measured by the same standard used by the commission) before the control was instituted, were either not available or utilized for the purpose of comparison.

[8] See reference, footnote 5.

TABLE 5.—*Catches and findings in Atlantic, Gulf, and Pacific Company and Tungkong Manga.*

ATLANTIC, GULF, AND PACIFIC COMPANY.

Year and month.	Number caught.	Positives. Stomach.	Positives. Salivary gland.	Positives. Total infected.	Infective (sporozoite) density. One in—
1928					
January	311	7	3	10	104
February	29	3		3	
March	12				
April	7				
Total	[a] 340	10	3	13	
Average catch per positive month (density)	170				
Average catch per negative month (density)	10				
Average monthly infective density					113

TUNGKONG MANGA.

Year and month.	Number caught.	Positives. Stomach.	Positives. Salivary gland.	Positives. Total infected.	Infective (sporozoite) density. One in—
1928					
December	273				
1929					
January	1,367	1		1	
February	849	2	1	3	849
March	917	1		1	
April	1,086		1	1	1,086
May	13		1	1	13
June	39				
July	18				
August	4				
September	1				
October	20				
November	166				
December	282				
Total	[a] 4,232	4	3	7	
Average catch per positive month (density)	846				
Average catch per negative month (density)	100				
Average monthly infective density					1,411

[a] Total for positive months only. A, G, & P. Co. by exposure. Trap used in Tungkong Manga since June, 1929.

The unaccountable marked drop in *A. funestus* densities in 1929 in North Portal and Tungkong Manga (February in the former and May in the latter), two distant places (Tables 3 and 5), is significant and explains the sudden diminution or disappearance of transmission in certain localities, which are often attributed to control measures. It would not be surprising if some of the places investigated by the commission were instances

of this nature. On the other hand, the high density maintained in South Portal in 1928 is most favorable for continuous or hyperendemic malaria which, as has been experienced, was not amenable to larval control, while the monthly and infective densities in 1929 (124, and 1 in 124, respectively) might have easily been affected by larval destruction.

It is also clear how a small number of *A. funestus* (120 per month of twenty-three catching days in La Mesa in 1928 or 5 per night) can produce considerable malaria (infective density, 1 in 52). A similar condition might have prevailed at Ennur as cited by James,[8] as it would have required three experienced observers four days to catch the sixty mosquitoes.

The data presented show clearly that a quantitative measure alone of the transmitting species, no matter how careful and systematic it is, does not give the same amount of necessary information that their systematic collection and examination for sporozoites do on the epidemiology of malaria, when it is considered that the factors of suitable human carriers and susceptibles are continuously variable. In case the vectors bite animals with frequency, the density should be corrected by using a precipitin-test factor. Mosquito density in a locality at a given period is of importance only when the infective number in the same locality during that period is known. With these two adequate data available, the amount of malaria in a susceptible community is directly proportional to the adult density of the carrying species. The procedure for these determinations seems simpler, and the results scientifically more accurate and direct because only mosquitoes are dealt with, dispensing with the uncontrolled human-carrier movement and the still more difficult work of determining who and how many are the carriers and for how long a period they will be suitable mosquito infectors, and the equally difficult task of differentiating between the new attack and the relapse in the measurement of malaria in man.

If the catches in the four negative places (Table 6) could be considered sufficient, the low density and probably a 1 to a very high figure of infective density (for example, 1 in 2,000 or more) explain why evidence of malaria transmission was not

[8] "Thus at Ennur in Madras where most of the inhabitants suffered from malaria, the infecting species of anopheline was so rare that three experienced observers were occupied for several days in catching about sixty specimens." See reference, footnote 2.

observed and new cases were not as prevalent in them as in the other camps with similar topography and mosquito fauna.

TABLE 6.—*Catches by exposure in four negative places.*

Place.	Year and month.	Number caught.
	1927	
Novaliches	December	2
	1928	
Do	January	122
Do	February	150
Do	March	274
Do	April	39
Total		585
Average per month (density)		117
	1929	
Santo Cristo	May	13
Do	June	11
Do	July	16
Do	August	0
Do	September	1
Do	October	2
Do	November	100
Do	December	123
Total		266
Average per month (density)		33
	1929	
Bigti	October	2
Do	November	107
Do	December	82
Total		191
Average per month (density)		64
	1929	
Alinsangan	November	23
Do	December	18
Total		41
Average per month (density)		20

SUMMARY

1. Data collected from ten places consisting of dissections of about 22,000 *Anopheles funestus* from September, 1927, to December, 1929, inclusive, show monthly (twenty-three catching days) and yearly variations in densities in different localities and in different periods of the same locality as measured by systematic catches by trapping with human bait or by exposure.

TABLE 7.—*Summary showing average monthly densities, positive and negative months, and infective numbers in five places where sporozoites were found by dissection.*

Place.	Year.	Monthly density positive months.	Monthly density negative months.	Average monthly infective number. One in—
South Portal	1927	234		177
Do	1928	480		69
Do	1929	124	67	124
La Mesa	1927	500		400
Do	1928	120	34	52
North Portal	1928	412	56	515
Do	1929	833	87	1,250
Atlantic, Gulf, and Pacific Company	1928	170	10	113
Tungkong Manga	1929	846	75	1,411

2. The infective density or number (sporozoite rate) varied in different places, and in the same place in different periods due to variations in the ever changing human-carrier factor.

3. Much malaria with few transmitters and vice versa exist and can be explained by a knowledge of the density and the infective number of the place at the time.

4. Natural unexplained marked decline in density has been observed in two places and explains the sudden disappearance of transmission in certain uncontrolled localities, which are often attributed to antimalarial measures in controlled areas.

5. The numerical prevalence of the transmitting species alone means little in the epidemiology of malaria, neither can a known density in one locality be utilized for comparative purposes in another. However, the direct relationship of the vector's density to malaria transmission in a locality at a certain period, when the corresponding infective number for that locality and period is known, has been shown to operate in nature.

6. A study of the densities and sporozoite rates of the transmitting species in several localities of the Novaliches water project over an extended period has revealed at least some of the fundamental causes of the different behaviors of malaria incidence that were formerly obscure.

7. Important documents have been quoted and discussed in the light of the present findings. They show that opinions on numerical anopheline prevalence and malaria incidence have apparently been based on inadequate field data.

FRESH-WATER SPONGES OF THE PHILIPPINE ISLANDS

By N. GIST GEE

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FOUR TEXT FIGURES

Very little has as yet been done toward the study of the fresh-water sponges of the Philippine Islands. Doubtless, a little time spent by collectors in examining the lakes, ponds, and streams of the Islands would yield a rich supply of interesting new materials. So far as I can learn only four species of this group have up to date been recorded from the Islands and all of them were described as new to science.

The first species is recorded by W. Weltner,[1] who describes *Ephydatia fortis* as a new sponge and gives the following note concerning its occurrence and collector: "Libmananfluss auf Luzon, Museum Berlin, Jagor leg." The type specimen of this sponge is in the Berlin Museum.

The other species were described by Annandale from material in the United States National Museum. He [2] described two new species, *Spongilla philippinensis* and *Spongilla clementis,* which were collected by Mary Strong Clemens in January, 1907, at Camp Keithley, Lake Lanao, Mindanao, at an elevation of 2,250 feet. In another paper Annandale [3] again reports upon Philippine fresh-water sponges. Paul Bartsch collected some specimens of fresh-water sponges from Vicars Landing, Lake Lanao, Mindanao, in May, 1908. These were determined by Annandale to be *S. philippinensis;* this makes a second locality in Lake Lanao in which this sponge has been found.

Other fresh-water sponges were collected by Hugh M. Smith, of the expedition of the Bureau of Fisheries steamer *Albatross,* December 26, 1907, from Taal Lake, on the east side of Taal Island, Luzon. Annandale called this sponge a new species and named it *Spongilla microsclerifera.*

[1] Spongillidenstudien III, Archiv fur Naturg. 1 (1895) 141.
[2] Proc. U. S. Nat. Mus. 36 (1909) 629–632.
[3] Proc. U. S. Nat. Mus. 37 (1909) 131, 132.

The type specimens of the last three sponges are in the United States National Museum.

Without doubt there are other fresh-water sponges to be found in the Philippine Islands and the writer would be pleased to receive specimens for study. They may be dried in the shade, wrapped in soft paper, and then sent by post in small tin boxes or in strong, light, wooden cigar boxes. Specimens should, if possible, contain gemmules, but even when without them they should be gathered. A former correspondent, now deceased, wrote of the great abundance of these sponges on the fishing traps in the waters near Los Baños, but he unfortunately did not send me specimens of these.

SPONGILLA PHILIPPINENSIS Annandale, 1909. Text fig. 1.

Historical statement.—This sponge was collected in January, 1907, by Mary Strong Clemens, at Camp Keithley, Lake Lanao, Mindanao, Philippine Islands, at an altitude of 2,250 feet. It was sent by the United States National Museum, together with other sponges, to Dr. N. Annandale, of the Calcutta Museum, for identification. His illustrated description was published in 1909.[4] Since the very small bit of this sponge, which the United States National Museum has kindly given me, contains no gemmules and is too small to give any idea of the structure of the sponge, I shall quote in full Annandale's original detailed description.

Habitat.—Paul Bartsch collected additional specimens of this species at Vicars Landing in the same lake in May, 1908. They were taken in shallow water and were attached to the submerged drift around the edge of the lake.

General characteristics.—"The sponge has evidently formed a sheet of considerable size adherent to some solid body, but has been broken into small pieces in the type specimens, which are about one centimeter thick. The surface is smooth with numerous oscula level with it. There is no trace of branches."

Color.—"Externally the sponge appears to have been bright green in color, but the basal parts are yellowish." It is gray in alcohol.

Structure.—"The texture is light and friable, by no means elastic. In vertical section both radiating and transverse fibers are visible to the naked eye and the sponge has a distinctly reticulate appearance, although the vertical interspaces are

[4] Proc. U. S. Nat. Mus. 36 (1909) 629–631.

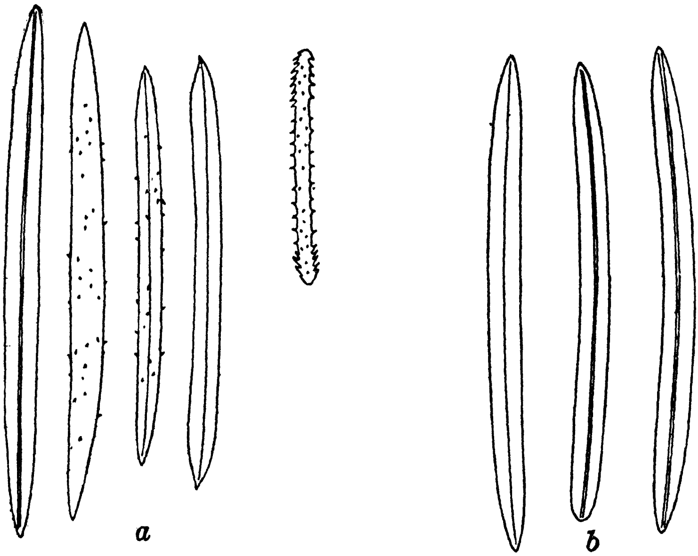

FIG. 1. *Spongilla philippinensis* Annandale. *a*, Showing both the smooth and the spined skeleton spicules; also one gemmule spicule (after Annandale); *b*, smooth skeleton spicules with axial canals clearly showing. (Drawing by C. F. Wu.)

much more conspicuous than the horizontal ones. Wide circular canals penetrate the sponge in a course parallel to the base. Comparatively little spongin is present. Under the microscope it is evident that the radiating fibers are much more coherent and regular than the transverse ones. On the external surface of the sponge a network of the horizontal spicules can be distinguished. There is a delicate, basal structureless membrane. The ectodermal membrane has perished."

Skeleton spicules.—"The skeleton spicules measure 0.174 mm. to 0.278 mm. in length and on an average 0.021 mm. in greatest transverse diameter. They are very sharply pointed at both ends, straight or nearly so, smooth or somewhat sparsely covered with extremely minute projections, the ends being always smooth."

I find these spicules to range between 229 and 271 μ in length and between 14 to 20 μ in diameter. In the slides that I have examined I have found no spined spicules at all.

Flesh spicules.—There are no flesh spicules.

Gemmules.—"There are few gemmules, those that exist occurring singly in the substance of the sponge and being free. They have a blackish color, are spherical, measuring on an average 0.609 mm. in diameter. Each is provided with a single

aperture, to which a short, straight, rather stout foraminal tubule is attached. The inner chitinous coat is rather thin, but the granular coat is well developed and contains many spicules, which are arranged horizontally or nearly so as a rule, but sometimes to a slight extent tangentially."

Gemmule spicules.—"The gemmule spicules are very variable in length, measuring from 0.0798 mm. to 0.122 mm. in length and about 0.0031 mm. in transverse diameter. They are cylindrical, straight or nearly so, armed with somewhat irregular spines, which are often slightly retroverted at the two ends. Sometimes there is a single straight spine at either end, but often the spicule ends abruptly and is surrounded by a ring of spines in such a way as to suggest a rudimentary rotule."

Type.—The type is preserved in the collection of the United States National Museum in Washington. I have a small, gemmuleless specimen (No. 54337) from that museum in my collection.

Distribution.—*Spongilla philippinensis* has so far been found only in Lake Lanao, but a closely related form, *S. sceptrioides*, has been described from New South Wales and Queensland, Australia.

Remarks.—From the descriptions and illustrations of *S. philippinensis* and *S. sceptrioides* given by Annandale, it seems that the spicules of these two sponges are very similar and I doubt very much that they are both entitled to separate specific rank. It is very desirable that new material of both of these sponges be collected for further comparison before a final decision is reached. *S. philippinensis* is also related to *S. alba* but is readily distinguished from it "by having minutely spined megascleres, green corpuscles, slender gemmule spicules with short spines and no free microscleres."

Concerning the specimens collected by Bartsch in May, 1908, Annandale writes that while no gemmules were present, the sponges were full of embryos. "The embryos lie in the interstices of the skeleton and have no protecting membrane as is the case in some oriental species (Records of Indian Mus., Vol. 1, p. 269 (1907). They are so numerous that in preparations made by boiling pieces of the sponge in nitric acid their minute immature skeleton spicules are present in sufficient numbers to appear to be a feature of the species and might easily be mistaken for free microscleres. True flesh spicules are, however, absent."

SPONGILLA CLEMENTIS Annandale, 1909. Text fig. 2.

Historical statement.—In January, 1907, Mary Strong Clemens collected this species at Camp Keithley, Lake Lanao, Mindanao, Philippine Islands. The altitude of the lake is 2,250 feet. This sponge was described and illustrated by Annandale.[5] Annandale described a similar sponge from Tali Fu, Yunnan, China, calling it at first *Spongilla yunnanensis*[6] but later,[7] he corrected this and designated that sponge also as *S. clementis*. The same author, in 1916, also described the same species from Lake Biwa, Japan.[8] The description that follows is based upon Annandale's descriptions of the several forms examined by him and my observations upon a small specimen of the original Philippine material kindly furnished me by the United States National Museum, a small bit of the Tali Fu sponge kindly provided by the Indian Museum, and a splendid series of specimens from Japan kindly given me by Doctor Kawamura, of the Biological Station at Otsu.

Habitat.—In Lake Lanao this sponge was found growing in close association with *Spongilla philippinensis*. In Yunnan it was found growing on small stones in the lake where it formed small rounded masses. In Lake Biwa it grew in three quite distinct phases: (1) It formed flat crusts of irregular outline usually less than 10 millimeters in thickness. (2) This phase also formed crusts, but was more massive than the first and at times developed "thick ramifying horizontal branches." Both of these phases were found growing on the pillars of bridges and piers and other similar supports, and sometimes covered considerable areas. (3) The third phase differs decidedly from the other two; it formed "compact, ovoid, spherical, irregularly massive or pedunculate masses." These masses grew on certain living mollusks or were found on stones, sticks, or lying free on the clean, sandy bottom of the lake in deep water.

General characteristics.—"In general appearance and color, this sponge, judging from the dry specimens, closely resembles *Spongilla philippinensis*, but the surface is usually covered with a network of deep, broad furrows which separate small elevated areas of more or less circular form. The oscula occur on these elevated areas and are large and numerous. Prob-

[5] Proc. U. S. Nat. Mus. 36 (1909) 631–632, fig. 4.

[6] Rec. Indian Mus. 5 (1910) 197.

[7] Mem. Asiatic Soc. Bengal. 6 (1918) 201.

[8] Journ. Coll. Sci. Tokyo 39 (1916) 7.

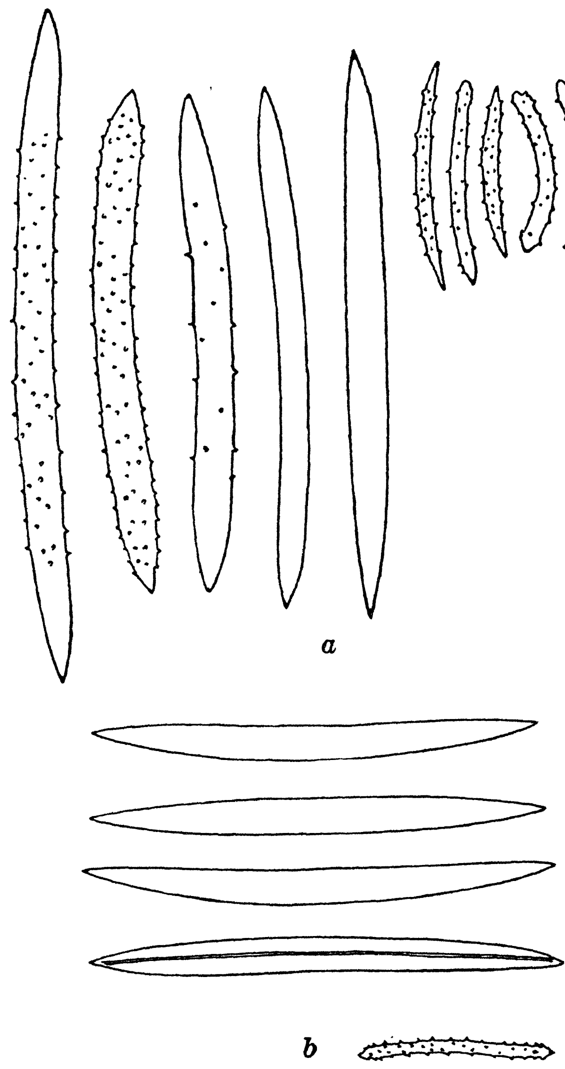

FIG. 2. *Spongilla clementis* Annandale. *a*, Spined and smooth skeleton spicules from specimens from Lake Biwa, Japan; the smaller spicules show the variations in gemmule spicules (after Annandale); *b*, skeleton and gemmule spicules of specimen from Lake Lanao, Mindanao; only smooth skeleton spicules were found (after Annandale).

ably in the fresh sponge the furrows are roofed in by the ectodermal membrane."

Color.—The color of the Philippine specimen of *S. clementis* was quite similar to that of *S. philippinensis,* green on the surface and yellowish underneath. The China representative of

this species was of a dull greenish color when growing. Annandale describes the colors of the various specimens of this sponge from Japan as "leaf green, grayish or yellowish, . . . tinged with green, but the color never extends to the interior, . . . grayish or whitish." The majority of our specimens (dry) from Japan are a light brown or straw color; a few are of a grayish color.

Structure.—"In vertical section the transverse fibers of the skeleton of this species from the Philippine Islands are seen to be stouter and more regular than those of *S. philippinensis,* being hardly inferior to the radiating fibers in these respects, so that the skeleton forms a much more regular network than is the case in the other sponge."

There is a good deal of variation in the consistency of the Japan sponges. Some of them have transverse fibers strong enough to make them quite firm and hard, while others are soft and easily crumbled. In the Philippine representatives of this species "there is a stout chitinous membrane, which sends bunches of hollow, root-like processes downwards at intervals. These do not appear to be in any way connected with the primary skeleton fibers. There are numerous scattered skeleton spicules in the basal membrane."

In the Japan forms, the oscula are usually numerous, large, and round and open upon the smooth surface of the sponge. Slight elevations or ridges may sometimes be formed around the oscula, or in some phases they may even develop crater-like cones.

Skeleton spicules.—Here again it is difficult to cover all variations in skeleton spicules in one general description. My specimens of both the Tali Fu and the Lake Biwa sponges have only smooth spicules in their skeletons. The Philippine sponge has a large majority of its spicules with spines, although the number of spines may vary from a very few small ones, which appear to be only granulations, to a rare spicule now and then that is thickly studded all over, except at the tips, which has prominent spines (fig. 3).

The spicules of the Japan forms closely resemble those of the Yunnan specimen, and I am of the opinion that these two species more closely resemble the form described by Annandale as *S. clementis,* even though I evidently have a bit of what seems to be the original Philippine material from the United States

National Museum from which Annandale described this species. The resemblance between this Philippine sponge, *S. clementis,* and the one which Annandale describes as *S. sceptrioides* in the same paper is quite close. I think that additional material bearing gemmules will have to be secured before a final decision as to the identity of these several specimens can be reached.

The spicules of all of them are gently curved and average around 255 μ in length. There is probably more variation in the thickness of the spicules, the range being from 12 μ to over 20 μ in some of them. The China and Japan specimens are rather abruptly and bluntly pointed, while the Philippine specimen is more sharply and gradually pointed.

Flesh spicules.—There are no flesh spicules.

Gemmules.—Annandale found no gemmules in the Yunnan specimen. He found very few gemmules in the Japanese material; and I have not succeeded, after a careful and prolonged search, in finding even a single gemmule in all of my numerous specimens of this species representing all three phases from Lake Biwa. The gemmules are evidently extremely rare. Those observed by Annandale were at the base of the sponge attached to the basal membrane, and they very likely are, most often, left on the support when the sponge is removed. Annandale says concerning the Philippine sponge, "There are very few gemmules indeed. They occur singly in the basal membrane and are apparently closely adherent to the support of the sponge. Each measures about 0.325 mm. in diameter (the shape being spherical) and is provided with a single straight foraminal tubule on the summit. The granular coat is feebly developed, but there is a strong outer chitinous coat in continuity with the basal membrane. The gemmule spicules lie in this coat parallel to the surface of the gemmule but crossing one another at all angles."

Gemmule spicules.—"The gemmule spicules are slender, cylindrical, nearly straight. In the middle they bear minute irregular projections, which only take the form of actual spines towards the two ends. Each end terminates in a stout, straight spine, surrounded by a row of smaller spines at right angles to it. None of the spines are retroverted." They are about one-third of the length of the skeleton spicules.

Type.—The type is in the United States National Museum, Washington, D. C. I have a small specimen from that mu-

seum labeled as *S. clementis,* but it differs somewhat from the typical form of *S. clementis* as originally described and appears to be very similar to *S. philippinensis.*

Distribution.—This species was described from Lake Lanao, Philippine Islands. Later it was collected in Tali Fu, Yunnan, China, and then in great abundance and in three distinct phases, in Lake Biwa, Japan, and in the settling tanks of the waterworks of the neighboring city of Kyoto. The water supply of Kyoto comes from Lake Biwa.

Remarks.—Annandale calls attention to the following points in which *S. clementis* differs from *S. philippinensis.* It has shorter and smoother skeleton spicules; it has a more regular skeleton; it has a thicker basal membrane; it has adherent gemmules with their ill-developed granular coat. I would add, from Annandale's description, another difference; namely, none of its gemmule spicules have retroverted spines.

SPONGILLA MICROSCLERIFERA Annandale, 1909. Text fig. 3.

Historical statement.—This sponge was collected by Dr. H. M. Smith from Lake Taal on the east side of Taal Island, Luzon, December 26, 1907. It was described, without illustrations, by Annandale.[9] The United States National Museum has kindly made available to me a small bit of this sponge, but as it is so small and there are no gemmules in it I shall quote parts of the original description, adding my observations where I have material to justify this; that is, on the skeleton and the flesh spicules.

Habitat.—The sponge was reported as being abundant around the shores of the lake and as having been washed up by the waves on to the shore in large quantities during storms. The specimens examined by Annandale "appear to have coated both surfaces of leaves, which have perished and almost disappeared."

General characteristics.—The sponge is "light, fragile, tomentose, . . . apparently without branches and of no great thickness."

Color.—It is "of a dirty white color in dry specimen." In alcohol the color of my small specimen is a very light brown.

Structure.—"Skeleton practically devoid of spongin but forming a close and almost regular reticulation in which the radiating and transverse fibers are of approximately equal diameter. The

[9] Proc. U. S. Nat. Mus. 37 (1909) 131–132.

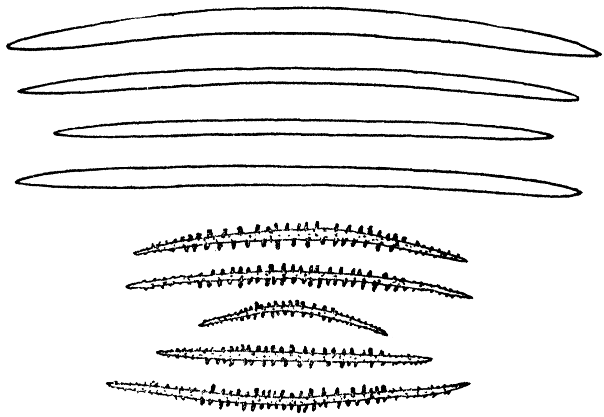

FIG. 3. *Spongilla microsclerifera* Annandale. Skeleton and fresh spicules. No gemmule spicules were found in my specimens. (Drawing by C. F. Wu.)

free microscleres are extraordinarily abundant in the interstices of the skeleton."

Skeleton spicules.—The skeleton spicules are smooth, slightly curved, rather slender and of nearly uniform diameter except near the ends where they become abruptly sharp-pointed. Scattered among the others in our preparations are a few heavier spicules which I suppose belong to some other sponge.

	Annandale.	Gee.
Length of spicule, μ	254–365	229–310
Diameter of spicule, μ	8.3	6–9

Flesh spicules.—The flesh spicules are very abundant. They are very variable in length and are extremely thin. As a rule they are decidedly curved and it is very rare that a straight one can be found. In the center where the spicule is thickest, the spines are heaviest and often end in rounded knobs; toward the ends of the spicules, where they become extremely tenuous, the spines are very minute and are sharper pointed. My measurements vary only very slightly from those of Annandale.

	Annandale.	Gee.
Length of spicule, μ	59.3–124.5	80–127
Diameter in thickest part, μ	1.03–2.07	1.50–3

Gemmules.—"Gemmules few, free, small, spherical, without a foraminal tubule, with a thick granular coat, in which the spicules are arranged tangentially and horizontally in an irregular manner. Diameter of gemmule 0.35–0.49 mm."

Gemmule spicules.—"Gemmule spicules slender, cylindrical, nearly straight, bluntly pointed at the ends, irregularly covered with short, sharp spines, which are more numerous at the extremities, at which they are usually directed backward, than in the middle."

Type.—The type is in the United States National Museum in Washington. I have a small piece of this sponge, without gemmules, in my collection.

Distribution.—This species has been reported up to date from only one locality; namely, Taal Lake, Luzon, P. I.

Remarks.—"The most noteworthy characters of this sponge are the number and hairlike appearance of the free microscleres which are sometimes of unusual length in spite of their tenuity. Otherwise there is very little, except perhaps color, to distinguish it from some forms of *Spongilla lacustris.* The specimens I have examined are dry and appear to be somewhat worn on the external surface, but there is no trace of their having borne branches; the oscula seem to have been fairly large. The skeleton, in spite of the closeness of its reticulation, contains much less spongin than is usually the case in *Spongilla lacustris,* but this is a character liable to a certain amount of variation, although perhaps less inconstant than is usually thought."

EPHYDATIA FORTIS Weltner, 1895. Text fig. 4.

Historical statement.—This sponge was described by Weltner [10] from a specimen collected by Jagor from Libmanan River, Luzon. Unfortunately there were no drawings to accompany the original description. Through the kindness of Dr. W. Arndt, of the University Zoölogical Museum in Berlin where the type is preserved, I have been able to secure a very minute cotype of this sponge. The following description and the illustrations are based upon that material and are supplemented by a translation from the original description by the author of the species.

Habitat.—The specimen described by Weltner was found growing on the leaves of a small water plant, *Vallisneria,* in Libmanan River, Luzon.

General characteristics.—My small specimen seems to be a portion of a very thin crust or film, which was apparently taken from a plant leaf.

[10] Archiv. fur Naturg. (1895) 141.

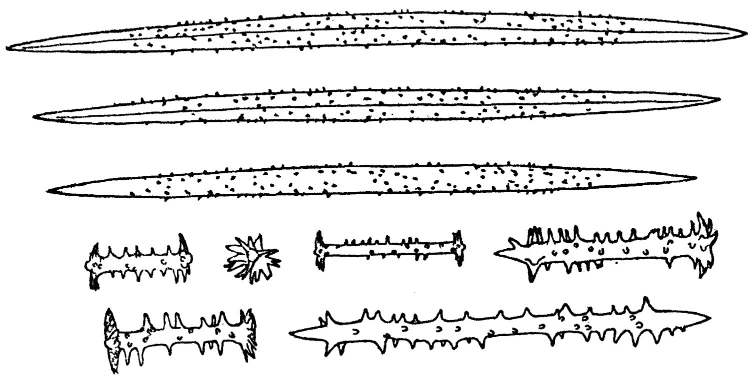

FIG. 4. *Ephydatia fortis* Weltner. Spiny skeleton spicules and five of the numerous variations in the gemmule spicules. (Drawings by C. F. Wu.)

Color.—When dry the sponge is white; the gemmules are also almost white, but are tinged with a very light brown. In alcohol the specimen is nearly transparent.

Structure.—The amount of spongin present is very small and the sponge appears to be very fragile. The long spicules, singly or in groups of two or three bound together near their ends, are woven into large open meshes. A thin basal membrane still shows the venation of the leaf to which the sponge was originally attached.

Skeleton spicules.—The large skeleton spicules are spindle-shaped, thickest in the center, gradually and sharply pointed; generally slightly curved, a few are straight; nearly always thickly covered, except near the ends, with minute spines perpendicular to the spicule; even the ends are sometimes finely granular in appearance; only occasionally are smooth or nearly smooth spicules found and most of these appear to be immature ones. My measurements show a slightly greater average length than Weltner's, but this might easily be caused by a chance selection of the spicules measured, and I consider it a matter of no special significance.

	Weltner.	Gee.
Length of spicules, μ	270–360	297–391
Average, around, μ	300	325
Diameter of spicules, μ	14–16	13–16

Flesh spicules.—There are no flesh spicules in this species.

Gemmules.—The gemmules occur singly in the meshes of the sponge. They are irregular in shape; some are nearly spherical,

while others are somewhat flattened out in one direction making them appear oblong. They are covered by a layer of birotulate spicules arranged perpendicularly to the surface of the gemmule, and in one gemmule the outer rotules were clearly visible as slight depressions in the thin cuticle that covered the gemmule. Weltner states that the pore tube is somewhat sunken in the air-cell layer. He also gives the average diameter of the gemmules as 480 μ. I measured two gemmules with the following results: 340 by 382 μ and 467 by 510 μ. The first gemmule measured had its covering spicules disarranged through handling, while in the second the cuticle was not disturbed. The measurements in both cases included the gemmule spicule layer.

Gemmule spicules.—The gemmule spicules vary a great deal in length and in general structure. While most of them are provided with the usual indented terminal rotules characteristic of the genus *Ephydatia*, yet quite a number of abnormal or irregular spicules occur. One of the commonest of these is a long (up to 135 μ or longer), heavily spined spicule that terminates in a large, smooth, sharp spine at each end; at the base of this spine there is a circle of shaft spines, somewhat larger than the others, that forms a rudimentary rotule. In some of the other spicules, which have the normal rotules, the shaft projects at one or both ends into a sharp point or spine beyond the rotule. My observations of the normal spicules agree in detail with those given by Weltner. The spicules vary in length from about 35 to 65 μ and the rotules have a diameter of from 20 to 28 μ. Both rotules of a spicule are usually of about the same diameter. They are irregularly incised, the teeth varying much in size, and in number from ten to twenty. The shaft is thickly covered with heavy spines, most of which usually bear smaller spines. There is much variation in the number of spines on the shafts of different gemmule spicules, some bear only eighteen or twenty, while others have as many as forty or more.

Type.—The type of this species is in the University Zoölogical Museum in Berlin. I have a minute cotype in my collection.

Distribution.—This species has been found only in Luzon, Philippine Islands. The writer has recently described [11] a variety of this species from specimens collected by Dr. J. R. Baker from the New Hebrides Islands.

[11] *Ephydatia fortis* var. *hebridensis,* Ann. and Mag. Nat. Hist. X 3 (1929) 28–33, figs.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Spongilla philippinensis* Annandale. *a*, Showing both the smooth and the spined skeleton spicules; also one gemmule spicule (after Annandale); *b*, smooth skeleton spicules with axial canals clearly showing. (Drawing by C. F. Wu.)

2. *Spongilla clementis* Annandale. *a*, Spined and smooth skeleton spicules from specimens from Lake Biwa, Japan; the smaller spicules show the variations in gemmule spicules (after Annandale); *b*, skeleton and gemmule spicules of specimen from Lake Lanao, Mindanao; only smooth skeleton spicules were found (after Annandale).

3. *Spongilla microsclerifera* Annandale. Skeleton and fresh spicules. No gemmule spicules were found in my specimens. (Drawing by C. F. Wu.)

4. *Ephydatia fortis* Weltner. Spiny skeleton spicules and five of the numerous variations in the gemmule spicules. (Drawings by C. F. Wu.)

PLANKTON DIATOMS FROM VLADIVOSTOK BAY

By B. W. Skvortzow

Of Harbin, China

TWO PLATES

The diatoms included in this paper were collected by Mr. N. E. Kabanov and me in Vladivostok Bay July 18, 1928. So far as I know, there is no published list of plankton diatoms from this part of the Sea of Japan and the enumeration will be of interest. The number of forms in the present collection is not great, but there are some interesting ones. I am describing a species of *Synedra* as new.

LEPTOCYLINDRUS DANICUS Cleve. Plate 2, fig. 3.

Cleve, Pelag. Diat. fr. Kattegat (1889) 54; Planktonundersokningar Cilioflag. och Diat. (1894) 15, pls. 1, 2, figs. 4, 5; Hustedt in A. Schmidt, Atlas Diatom. (1920) pl. 321, fig. 12; Kieselalgen (1929) 558–59, figs. 318, 319.

Cells cylindrical, with flat ends, forming filaments. Valves without structure. Chromatophores numerous. Diameter of filaments, 0.007 to 0.008 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

SCELETONEMA COSTATUM (Grev.) Cleve. Plate 2, fig. 4.

Cleve, Bih. Kongl. Sv. Vet.-Akad. Handl. 5 (1878) 18; A. Schmidt, Atlas Diatom. (1892) pl. 180, figs. 41–45; (1920) pl. 321, figs. 5, 6; Hustedt, Kieselalgen (1928) 311–13, fig. 149.

Cells 0.007 to 0.009 millimeter broad, 0.018 to 0.022 in length. Geographic distribution: A typical pelagic diatom known from the Atlantic and Pacific Oceans.

DITYLIUM BRIGHTWELII (West) Grun.

V. Heurck, Synopsis (1885) pl. 114, figs. 3–9.

Cells 0.12 to 0.15 millimeter in length, 0.025 to 0.035 in breadth. Geographic distribution: Common in plankton of oceans, known from the Sea of Japan.

CHAETOCERAS SOCIALE Lauder. Plate 1, fig. 2.

LAUDER, Diatom. Hong Kong (1864) 77, pl. 8, fig. 1.

I am giving here the original diagnosis of this species, from Henry Scott Lauder:

> Filaments slender, aggregated, embedded in gelatine, with wiry spirally dotted awns, some of which are more elongate and converge to a common centre. This is the smallest species I have seen. By the aggregation of the filaments in gelatine, it forms roundish, flattened fronds. Frustules quadrate with an awn from a little within each angle, one of them being more elongated, varying in the length, according to the distance of the frustules, to a common centre, to which the elongated awns converge: many frustules, however, occur in which the awns are not thus connected: side view oval.

Our specimens were 0.008 to 0.01 millimeter in diameter. Geographic distribution: Atlantic and Pacific Oceans; known from Japanese waters.

CHAETOCERAS CRIOPHILUM Castracane forma **VOLANS** (Schutt) Gran. Plate 1, figs. 5 and 6.

CASTRACANE, Diatom. Challenger (1886) 78; GRAN, Diatom. Arct. Meere (1904) 532–33, fig. 4; Nord. Plankton (1906) 71, fig. 85; GRAN and YENDO, Japan Diatom. (1914) 7; OKAMURA, Littor. Diatom. Japan (1911) 90, pl. 3, figs. 33–37; KARSTEN, Phytopl. Antarkt. Meeres (1905) 118, pl. 15, fig. 8; PERAGALLO, Diatom. Mar. France (1908) 475; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 342, figs. 2, 3.

Cells solitary, 0.02 to 0.023 millimeter broad, from front view quadrangular with angles. Setæ very robust, curved, covered with solid spines. Geographic distribution: Atlantic and Pacific Oceans; the Sea of Japan.

CHAETOCERAS COMPRESSUM Lauder. Plate 1, fig. 1.

LAUDER, Diatom. Hong Kong (1864) 78, pl. 8, fig. 6.

Chain straight, 0.01 to 0.018 millimeter broad. Spores with verrucose dots on the margin. Geographic distribution: Common in Atlantic and Pacific Oceans. Reported from the Sea of Japan.

CHAETOCERAS COMPRESSUM var. **GRACILIS** Hustedt. Plate 1, fig. 7.

HUSTEDT, in A. Schmidt, Atlas Diatom. (1921) pl. 338, fig. 7.

Chain thinner, 0.006 to 0.008 millimeter broad. Geographic distribution: Known only from the Sea of Japan.

CHAETOCERAS DIDYMUM Ehrenb. var. **ANGLICA** Gran. Plate 1, fig. 3.

GRAN, Nord. Plankton (1906) 80, fig. 95.

Cells forming a straight chain, 0.02 to 0.03 millimeter broad. Cells in the front view rectangular with a large dot in the middle

part. Setæ start at a little inside of the margin. Geographic distribution: Atlantic and Pacific Oceans; Sea of Japan.

CHAETOCERAS GRACILE Schütt. Plate 1, fig. 10.

SCHÜTT, Chaetocera and Peragallo. (1895) 42, figs. 13*a–d.*
Chaetoceras septentrionale OESTRUP, Mar. Diatom. Gronland. (1895) 457, pl. 7, fig. 88; GRAN, Diatom. Arkt. Meere (1904) 542; PAULSEN, On some Perid. a. Plankt. Diatom. (1905) 5–6, fig. 6.

Cells solitary, 0.015 to 0.025 millimeter broad; in the front quadrangular and in valve view elliptical. Setæ thin, very long. Geographic distribution: Atlantic Ocean.

CHAETOCERAS DECIPIENS Cleve. Plate 1, fig. 8.

CLEVE, Diatom. Arct. Sea (1873) 11, fig. 5.

Chain straight, with rectangular cells, 0.035 to 0.55 millimeter broad. Geographic distribution: Atlantic and Pacific Oceans; Sea of Japan.

CHAETOCERAS CONSTRICTUM Gran. Plate 2, fig. 2.

GRAN, Tret. Phytopl. N. Atlant. (1897) 17, pls. 11–13, pl. 3, fig. 42; Nord. Plankton (1906) 80, fig. 96; OKAMURA, Chaetoceras and Perag. Japan (1907) 96, pl. 4, figs. 64a, b; PERAGALLO, Diatom. Mar. France (1908) 491, pl. 134, fig. 5; HUSTEDT in A. Schmidt, Atlas Diatom. (1921) pl. 338, fig. 1.

Chain straight, 0.01 to 0.012 millimeter broad. Cells in a front view rectangular with slightly projecting angles, valves concave, foramina lanceolate, constricted. Girdle band one-third of the cell height. Setæ thin, starting from the angles of the valve, crossing one another close to their insertions, diverging at an obtuse angle. Terminal setæ are not differentiated. Geographic distribution: Atlantic and Pacific Oceans.

Okamura reports this species from the Kuriles.

CHAETOCERAS LACINIOSUM Schütt. Plate 2, fig. 1.

SCHÜTT, Arten Chaetoceras u. Peragallo. (1895) 38, figs. 5a–c; GRAN, Phytopl. N. Atlant. (1897) 17, figs. 4–7; Nord. Plankton. (1906) 82, fig. 99; GRAN and YENDO, Japan Diatom. (1914) 18–19, fig. 11.
Chaetoceras distans CLEVE, Plankton. Cilioll. och. Diatom. (1894) 14, pl. 2, fig. 3.
Chaetoceras distans OSTENFELD, Flora Koh-Chang (1902) 255, fig. 13.
Chaetoceras commutatum CLEVE, Plankton. Vegetabil. (1896) 28, figs. 9, 10.
Chaetoceras ostenfeldii CLEVE, Plankt. N. Sea (1900) 21, pl. 8, fig. 19.
Chaetoceras pelagicum CLEVE, Diatom Arct. Sea (1873) 11, pl. 1, fig. 4.

Chaetoceras distans var. *laciniosa* SCHÜTT in Peragallo, Diatom. Mar. France (1908) 483, pl. 132, fig. 6; IKARI, Chaetoceras Japan (1928) 253–54, fig. 8a.

Chain straight, 0.01 to 0.015 millimeter broad, composed of many cells. Foramina large, as long as the cell height and elliptical, slightly constricted in the middle. Valves in a front view rectangular with projecting angles. Girdle band rather longer, about two-thirds of the cell height. Setæ thin, starting from the angles of the valve, crossing one another close to their insertions, diverging at an obtuse angle. Terminal setæ are disposed parallel. Geographic distribution: Common in Atlantic and Pacific Oceans. Known in Japanese waters from Oshoro, Takashima, Ajiro, Naha, Volcano Bay, Misume, and Seto.

CHAETOCERAS sp. Plate 1, fig. 4.

Chain straight, 0.012 to 0.015 millimeter wide. Cells in a front view rectangular, valves concave, foramina lanceolate. Girdle band rather longer, about one-third of the cell height. Setæ thin, irregularly disposed, terminal setæ long, more or less divergent.

THALASSIOTHRIX NITZSCHIOIDES Grun. Plate 2, figs. 7 and 8.

V. HEURCK, Synopsis (1883) 43, fig. 7.

A common pelagic diatom forming zigzag clusters. Cells lanceolate, 0.012 to 0.074 millimeter in length, 0.0025 to 0.003 in breadth with marginal striæ 12 to 15 in 0.01 millimeter. Geographic distribution: North Atlantic and Pacific Oceans.

THALASSIOTHRIX FRAUENFELDII Grun. Plate 2, fig. 9.

V. HEURCK, Synopsis (1883) pl. 37, figs. 11–13.

Cells forming star-shaped or zigzag clusters. Cells 0.002 to 0.15 millimeter in length. Geographic distribution: Atlantic and Pacific Oceans. Sea of Japan.

THALASSIOTHRIX ANTARCTICA Schimper. Plate 2, figs. 5 and 6.

KARSTEN, Phytopl. Atlant. Meeres (1905) 124, pl. 17, fig. 12.

Cell filiform, curved, 1.32 to 1.65 millimeters in length, 0.0037 to 0.005 in breadth. Striæ 14 to 16 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

ASTERIONELLA JAPONICA Cleve. Plate 2, figs. 10 and 11.

OKAMURA, Littor. Diatom. Japan (1911) 11, pl. 13, fig. 56.

A typical pelagic diatom forming star-shaped and zigzag clusters. Cells length 0.045 to 0.144 millimeter. Geographic distribution: Atlantic and Pacific Oceans; Sea of Japan.

SYNEDRA AFFINIS Kutz. var. **GRACILIS** Grun.

V. HEURCK, Synopsis (1883) pl. 41, fig. 15B; PERAGALLO, Diatom. Mar. France (1908) 320, pl. 130, figs. 23, 24.

Valve lanceolate, in the middle part inflated. Length, 0.35 to 0.44 millimeter; breadth, 0.012; striæ 12 in 0.01 millimeter. Geographic distribution: A littoral diatom known from the Atlantic and Pacific Oceans and Mediterranean Sea.

SYNEDRA JAPONICA sp. nov. Plate 2, fig. 13.

Cell free, linear or linear-lanceolate, pseudoraphe distinct. Valve 0.48 to 0.59 millimeter in length, in the middle part, 0.0034 to 0.0045 in breadth; striæ 15 in 0.01 millimeter.

RHIZOSOLENIA ALATA Bright. forma **GRACILLIMA** (Cleve) Grun.

PERAGALLO, Monogr. Rhizosolenia (1892) 20, pl. 5, fig. 12; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 317, figs. 8–10.

Cells 0.85 to 0.88 millimeter in length and 0.0074 in breadth. Geographic distribution: Common in plankton in Atlantic and Pacific Oceans.

RHIZOSOLENIA SETIGERA Bright.

PERAGALLO, Monogr. Rhizosolenia (1892) 17, pl. 4, fig. 12–16.

Cell linear, hyaline, 0.65 to 0.75 millimeter in length and 0.011 in breadth. Spine thin, 0.04 to 0.07 millimeter in length. Geographic distribution: Atlantic, Pacific and Indian Oceans, Sea of Japan.

NITZCHIELLA LONGISSIMA (Bréb.) Ralfs forma **PARVA** V. Heurck. Plate 2, fig. 12.

V. HEURCK, Synopsis (1883) pl. 70, fig. 3.

Length, 0.118 to 0.2 millimeter; breadth in the middle part, 0.0035 to 0.004. Geographic distribution: Littoral diatom, cosmopolitan.

PLEUROSIGMA FASCIOLA Ehrenb. var. **ARCUATUM** Donk. Plate 1, fig. 9.

Pleurosigma arcuatum DONKIN, T. M. S. (1858) 25 fig. 10; CLEVE, Synopsis Navic. Diatoms (1894) Part I, II; PERAGALLO, Monogr. Pleurosigma (1890 to 1891) 26, pl. 8, figs. 34, 35.

Valve lanceolate, with produced beak-shaped ends. Length, 0.1 to 0.15 millimeter; breadth, 0.015 to 0.018. Geographic distribution: A littoral diatom known from the Atlantic and Pacific Oceans.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Chaetoceras compressum* Lauder.
2. *Chaetoceras sociale* Lauder.
3. *Chaetoceras didymum* Ehrenb. var. *anglica* Gran.
4. *Chaetoceras* sp.
5. *Chaetoceras criophilum* Castr. f. *volans* (Schütt) Gran.
6. *Chaetoceras criophilum* Castr. f. *volans* (Schütt) Gran.
7. *Chaetoceras compressum* Lauder var. *gracilis* Hustedt.
8. *Chaetoceras decipiens* Cleve.
9. *Pleurosigma fasciola* Ehrenb. var. *arcuatum* Donk.
10. *Chaetoceras gracile* Schütt.

PLATE 2

FIG. 1. *Chaetoceras laciniosum* Schütt.
2. *Chaetoceras constrictum* Gran.
3. *Leptocylindrus danicus* Cleve.
4. *Sceletonema costatum* (Grev.) Cleve.
5. *Thalassiothrix antarctica* Schimper.
6. *Thalassiothrix antarctica* Schimper.
7. *Thalassiothrix nitzschioides* Grun.
8. *Thalassiothrix nitzschioides* Grun.
9. *Thalassiothrix frauenfeldii* Grun.
10. *Asterionella japonica* Cleve.
11. *Asterionella japonica* Cleve.
12. *Nitzchiella longissima* (Bréb.) Ralfs f. *parva* V. Heurck.
13. *Synedra japonica* sp. nov.

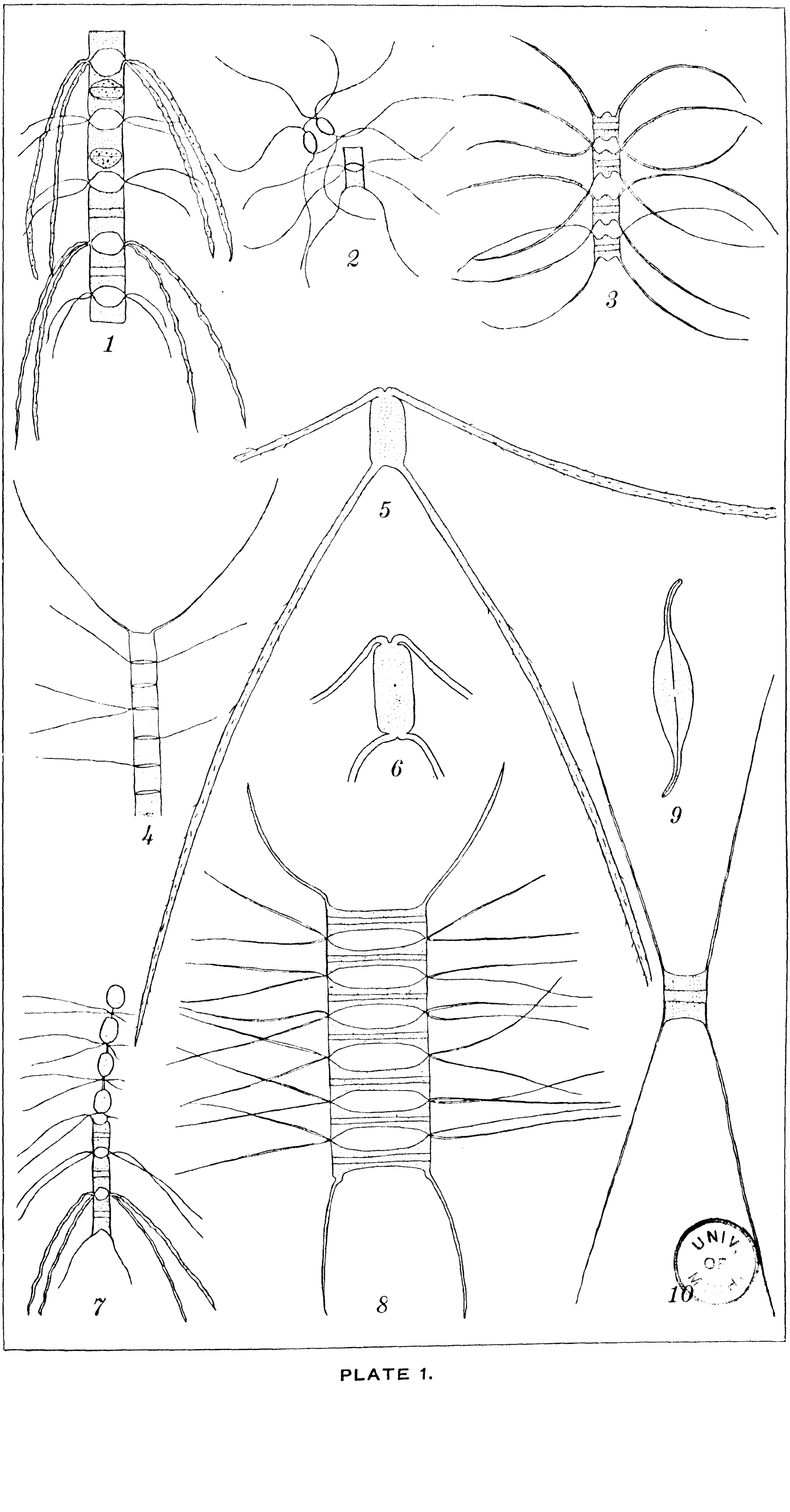

PLATE 1.

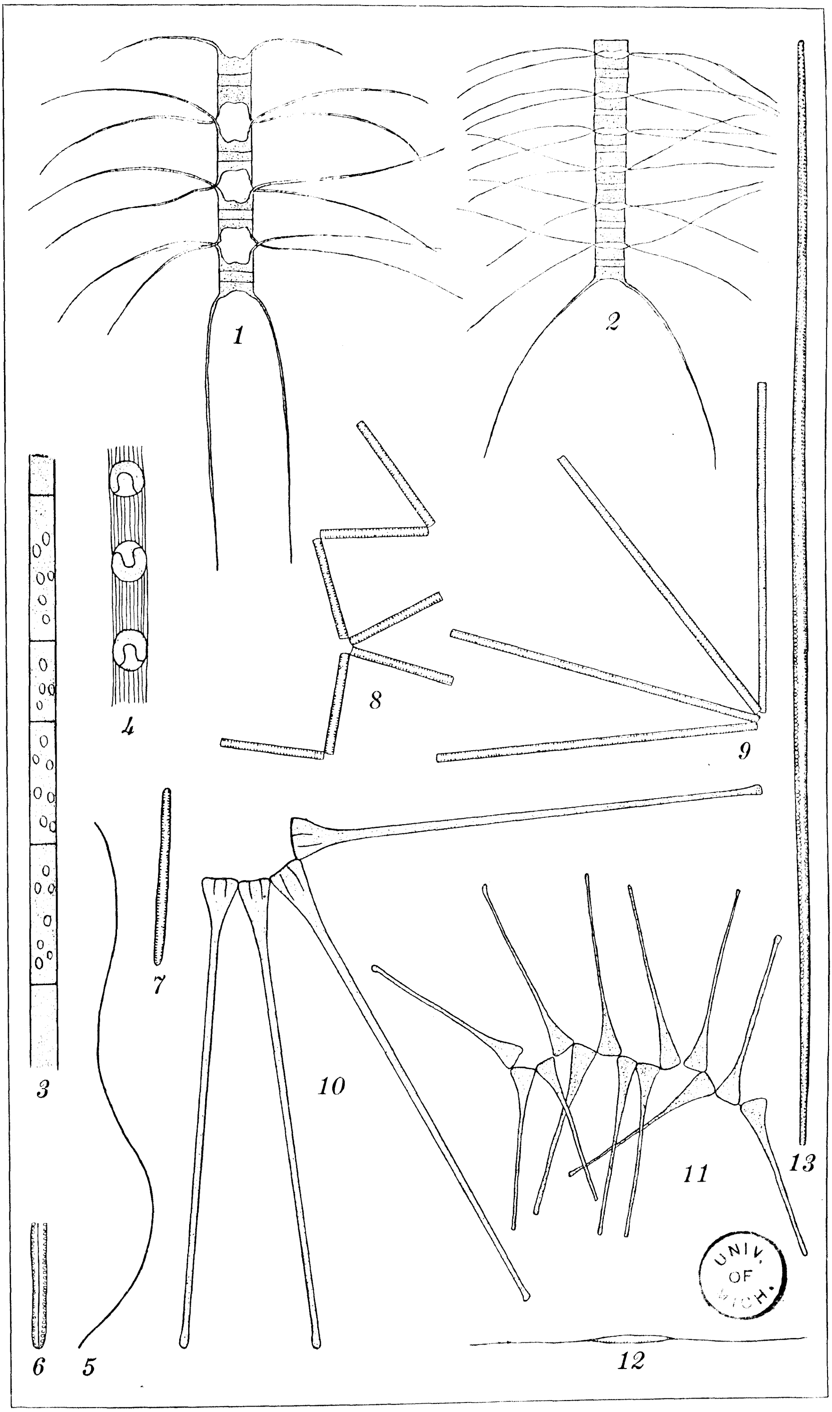

PLATE 2.

MYCETOZOA FROM NORTH MANCHURIA, CHINA [1]

By B. W. Skvortzow

Of Harbin, China

FIVE PLATES

A certain amount of work has been done on the Mycetozoa of some parts of Europe and the western parts of Asia, but the slime fungi of eastern Asia, especially of Manchuria, have been completely overlooked. Contributions to the Mycetozoa of Siberia have been published by Dr. N. N. Lavrov, of the Tomsk University of Siberia, USSR, and the Japanese Mycetozoa were studied by A. and G. Lister, in Mycetozoa from Japan;[2] and by K. Ninakata, in the list of Japanese Myxomycetes.[3]

The Mycetozoa that form the subject of this paper were collected by the author in North Manchuria in 1920 to 1929, especially in Harbin and in the mountainous part of the country near Erth'enkiangtzu and Maoershan station on the Chinese Eastern Railway. The number of forms found in the present collection is not great, but there are some interesting ones. In this note thirty-two slime fungi are enumerated and ten are described as new; namely, *Badhamia mandshurica, Physarum compressum, Ph. griseum, Ph. mandshuricum, Ph. asiaticum, Diderma rugosum* Macb. var. *asiatica, Lepidoderma mandshurica, Licea brassica, L. mandshurica,* and *Trichia asiatica.*

The Mycetozoa are cosmopolitan in their distribution and the finding of new species in the eastern part of Asia is of scientific interest. Most Manchurian forms of Mycetozoa are characteristic of temperate regions; such are, *Fuligo septica, F. muscorum, Diderma spumarioides, Stemonitis splendens, S. herbatica, Lycogala epidendrum, Trichia persimilis, T. contorta, Hemitrichia clavata, Arcyria denudata, A. cinerea,* and *Perichaena depressa.* Some species of slime fungi, *Ceratiomyxa fruti-*

[1] From the laboratory of natural history of the Third High School of the Chinese Eastern Railway Co., Harbin, China. (Formerly the Commercial School.)

[2] Journ. of Bot. 42 (1904) 97–99, t. 458; 42 (1906) 227–230.

[3] Bot. Mag. Tokyo 42 (1908) 317.

culosa, Didymium dubium, Licea biforis, Arcyria carnea, and others, are here recorded from Asia for the first time. All *Physarum* species found in Manchuria are identified as new to science.

This note is illustrated by diagrams by the author and by photographs made by Ica mikro-camera with Planar 1:4.5 F = 2 cm of Carl Zeiss.

CERATIOMYXA FRUTICULOSA Macbr. var. **FLEXUOSA** Lister. Plate 4, fig. 3.

Sporophores long, branching, white, 1 to 3 millimeters high. Branches of sporophores 30 to 60 microns, thickly covered with spines. Spores white, smooth, ovoid, 8 to 13 microns long. Habit: On rotten wood; near Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Abundant in the Tropics; recorded in Europe, Japan, and South Africa.

BADHAMIA MANDSHURICA sp. nov. Plate 2, figs. 6, 7, and 8.

Plasmodium unknown. Sporangia subglobose, sessile, minute, 0.2 to 0.5 millimeter in diameter, scattered or in small clusters, black, somewhat rugose and gray; sporangium wall membranous, with scanty deposits of lime granules. Capillitium a network of slender threads with white lime deposits. Spores free, blackish brown, round, somewhat minutely spinulose, 13 to 15.5 microns in length. Habit: On the bark of trees; Harbin, August, 1920.

PHYSARUM COMPRESSUM sp. nov. Plate 1, figs. 7, 8, and 9.

Sporangia stalked, gregarious, discoid or compressed, sometimes umbilicate above, 0.4 to 1 millimeter in diameter, grayish white, rugulose; sporangium wall membranous, with abundant deposits of white lime granules. Stalk furrowed, yellow-brown. Capillitium a persistent network of stout, rigid, hyaline threads and numerous rounded dark yellow-brown lime knots. Spores 11 to 12 microns in diameter, brown, spinulose. Habit: On dead wood; Harbin, August, 1920.

PHYSARUM GRISEUM sp. nov. Plate 1, figs. 4, 5, and 6.

Sporangia sessile, subglobose or elongate, clustered, grayish white, 0.4 to 0.7 millimeter in diameter, rugulose; sporangium wall membranous, with lime granules. Capillitium consisting of short hyaline threads connected by angular branching brown-yellow lime knots. Spores purplish brown, spinulose, 9.2 to 12 microns in diameter. Habit: On dead wood; Harbin, November, 1920.

PHYSARUM MANDSHURICUM sp. nov. Plate 1, figs. 1, 2, and 3.

Sporangia subglobose, reniform, stalked, erect or somewhat inclined, scattered or clustered, two or more often borne on a single stalk, 0.3 to 0.7 millimeter in diameter, white, rugose; sporangium wall membranous, with white granules. Stalk subulate or cylindrical, furrowed, 1 millimeter long, yellow-brown, usually free from refuse matter. Capillitium a network of colorless branching threads, lime knots large, not numerous. Spores dark reddish brown, spinulose, 11 to 12 microns in diameter. Habit: On dead bark of trees; Maoershan station, Chinese Eastern Railway, August, 1928.

PHYSARUM ASIATICUM sp. nov. Plate 2, figs. 9, 10, and 11.

Sporangia subglobose or irregularly ovoid, 0.2 to 0.5 millimeter in diameter, sessile, heaped or gregarious, rugose, whitish black; sporangium wall membranous, with dense included clusters of minute white lime granules. Capillitium a network of dark brown threads, with irregular dark brown lime knots. Spores dark violet-brown, 10 to 12 microns in diameter, spinulose. Habit: On bark of trees; Harbin, September, 1920.

FULIGO SEPTICA Gmelin. Plate 3, fig. 3; Plate 4, fig. 4.

Æthalia pulvinate, 0.5 to 7 centimeters broad, light yellow. Capillitium consisting of a loose network with yellow lime knots. Spores violet, smooth, 6.8 to 9.5 microns in diameter. Habit: On dead wood and earth; Harbin, July, August, and September, 1929. Geographic distribution: Abundant in temperate and tropical regions.

FULIGO SEPTICA Gmelin var. **RUFA** R. E. Fries. Plate 3, fig. 2.

Æthalia pulvinate, 2 to 4 centimeters in diameter, brick red or yellow-red. Capillitium scanty, consisting of a loose network of slender hyaline threads. Spores violet-brown, 6.8 to 9.6 microns in diameter. Habit: On earth and on leaves; near Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Abundant in temperate and tropical regions.

FULIGO MUSCORUM Alb. and Schwein.

Æthalia pulvinate, 0.4 to 0.8 millimeter in diameter, scattered, yellow. Capillitium of numerous irregular large orange lime knots. Spores violet-brown, spinulose, 10.2 to 12 microns in diameter. Habit: On bark of *Cladrastis amurensis;* Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Europe and Ceylon.

DIDERMA GLOBOSUM Pers. Plate 4, fig. 2.

Sporangia subglobose, sessile, forming large colonies, 0.2 to 0.5 millimeter in diameter, white-gray; sporangium wall of two layers, the outer eggshell-like, composed of globular lime granules. Columella indistinct. Capillitium dark brown branched threads. Spores dark black-brown, fine spinulose, 11 to 11.5 microns in diameter. Habit: On leaves and twigs of *Carex* sp. and *Artemisia* sp.; near Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Recorded from Europe, United States, and British Columbia.

DIDERMA SPUMARIOIDES Fries.

Sporangia crowded, forming colonies, globose, sessile, 0.5 to 1.5 millimeters in diameter, smooth, white. Sporangium wall of two layers. Capillitium slender threads. Spores dark reddish brown, spinulose, 7.4 to 11.1 microns in diameter. Habit: On dead wood; Harbin, August, 1920. Geographic distribution: Europe, United States, Canada, Ceylon, Japan, West Indies, Bermuda, and southern Chile.

DIDERMA RUGOSUM Macbride var. **ASIATICA** var. nov.

Plasmodium gray. Sporangia stalked, subglobose, 0.4 to 0.5 millimeter in diameter, grayish white, reticulated, wrinkled. Sporangium wall single, with deposits of lime in minute granules. Stalk 0.5 to 0.7 millimeter high, furrowed, yellow-brown. Columella clavate, about half the height of the sporangium. Capillitium consisting of slender colorless threads, anastomosing and branching towards the tips. Spores purplish brown, minutely warted, 7.5 to 9 microns in diameter. Habit: On leaves of *Brassica chinensis;* Harbin, August, 1928. Geographic distribution: The typical *Diderma rugosum* was recorded from Europe, Ceylon, Japan, America, and United States.

LEPIDODERMA MANDSHURICA sp. nov. Plate 2, figs. 1, 2, and 3; Plate 5, fig. 2.

Sporangia forming short, subglobose or elongate pulvinate plasmodiocarps, 0.5 millimeter to 5 centimeters long, 0.5 to 5 millimeters broad, silvery gray, clothed with brilliant crystalline scales of lime; capillitium of slender brownish threads, branched and anastomosing. Spores brown-violet, smooth, 6.8 to 7.2 microns in diameter. Habit: On leaves and dead twigs, Maoershan station, Chinese Eastern Railway, August, 1928.

STEMONITIS SPLENDENS Rost. var. **FLACCIDA** Lister.

Sporangia cylindrical, obtuse, stalked, dark brown, adhering to each other, forming large colonies. Stalk black. Total height

1 to 1.8 centimeters. Capillitium of purplish brown branching threads. Spores dark brown, 7.4 to 7.8 microns in diameter. Habit: On dead wood; Erth'enkiangtzu station, Chinese Eastern Railway, July, 1927. Geographic distribution: Europe and America.

STEMONITIS HERBATICA Peck.

Sporangia cylindrical, closely clustered, 8 to 10 millimeters high, brown. Stalks 2 to 3.5 millimeters high. Capillitium brown threads, forming a loose network. Spores smooth, 5.1 to 5.4 microns in diameter. Habit: On dead wood; Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Europe, United States, Ceylon, and Japan.

DICTYDIUM CANCELLATUM Macbr.

Sporangia subglobose, dark red-brown, stalked, formed of numerous ribs, connected by slender transverse threads, 1.5 to 2 millimeters high and 0.3 to 0.5 millimeter broad. Spores red, 5.2 to 5.7 microns in diameter, minutely warted. Habit: On dead wood; Harbin, August, 1920. Geographic distribution: Europe, Africa, America, and Japan.

LICEA BIFORIS Morgan.

Sporangia scattered, ellipsoid, elongate, sessile, 0.1 to 0.3 millimeter long, 0.06 to 0.1 millimeter broad, yellow-brown. Spores round, smooth, light yellow, 9.2 to 11.1 microns in diameter, with oil drops. Habit: On dead bark; Harbin, November, 1929. Geographic distribution: Japan, Pennsylvania, Ohio, and Canada.

LICEA BRASSICA sp. nov. Plate 3, fig. 4.

Sporangia scattered, depressed, forming straight, curved, or branching plasmodiocarps 0.5 to 5 millimeters long, grayish white, reticulated and little wrinkled. Sporangium wall single, with deposits of lime in minute granules. Spores purplish brown, smooth, 9.2 to 9.5 microns in diameter. Habit: On leaves of *Brassica chinensis*. This species somewhat resembles *Licea flexuosa* Pers., but differs from it in the color of the sporangium wall and by the spores.

LICEA MANDSHURICA sp. nov. Plate 2, figs. 4 and 5.

Sporangia sessile, depressed, forming straight, curved, and wrinkled plasmodiocarps, 1.5 millimeters long, olive or dark gray, more or less closely covered with flat, rounded, angular crystalline scales of lime. Capillitium and columella wanting.

Spores dark violet-brown, 6 to 7.2 microns in diameter, nearly smooth. Habit: On earth; Harbin, August, 1929.

LYCOGALA EPIDENDRUM Fries.

Æthalia subglobose, 5 to 6 millimeters in diameter, dark gray, warted. Pseudocapillitium in the form of tubes, marked with close transverse wrinkles. Spores gray, spinulose, 6.8 to 8.5 microns in diameter. Habit: On dead wood; Harbin, August, 1920. Geographic distribution: British Isles and frequent in all temperate and tropical regions.

TRICHIA PERSIMILIS Karst.

Sporangia globose, sessile, forming large colonies, 0.3 to 0.6 millimeter in diameter, yellow-brown. Capillitium 3.8 to 4 microns in diameter, with spiral bands and short spines. Spores yellow, 11.1 to 11.4 microns in diameter, with pitted warts. Habit: On rotten wood; Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: British Isles, Europe, Ceylon, Java, and Peru.

TRICHIA VARIA Pers.

Sporangia globose, ovoid, only sessile, 0.5 to 1 millimeter in diameter, forming large colonies. Sporangium wall membranous, pale yellow. Capillitium yellow, elater 3.5 to 4.5 microns in diameter, tapering at the ends, with two spiral bands. Spores yellow, minutely warted, 11 to 13 microns in diameter. Habit: On dead wood; Harbin, November, 1920. Geographic distribution: Europe, United States, Ceylon, and northern India.

TRICHIA CONTORTA Rost. var. INCONSPICUA Lister.

Sporangia clustered, forming large colonies; 0.2 to 0.7 millimeter in diameter, sessile, brown; sporangium wall membranous, reddish brown. Capillitium simple, elaters with four distinct spiral bands, 3.7 to 4 microns in diameter. Spores yellow, minutely spinulose, 11 to 13 microns in diameter. Habit: On bark of trees; Harbin, 1920. Geographic distribution: Widely distributed throughout north temperate regions.

TRICHIA ASIATICA sp. nov. Plate 1, figs. 10, 11, and 12.

Sporangia globose, usually crowded and seated on a common membranous hypothallus, 0.5 to 0.8 millimeter in diameter, brown or yellow-brown, shining. Capillitium and spores in mass yellow; sporangium wall membranous, yellow. Capillitium of bright yellow or orange elaters, 3.5 to 4 microns in diameter, with four bands, forming a close spiral studded with

many spines. Spores dark yellow-brown, minutely warted, 10 to 12.5 microns in diameter. Habit: On bark of trees; Harbin, November, 1929.

HEMITRICHIA SERPULA Rosr. Plate 5, fig. 1.

Sporangia forming winding branched plasmodiocarps, 0.2 to 0.5 millimeter wide, uniting into a close net, golden yellow; sporangium wall membranous, yellow. Capillitium elastic yellow threads, 4 to 4.5 microns in diameter, marked with spiral bands, spinose. Spores yellow, reticulated with bands, forming a regular net, 11 to 11.5 microns in diameter. Habit: On bark of trees; Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Europe, abundant in Japan, United States, the Tropics, Australia, New Zealand, and the Cape Province.

HEMITRICHIA VESPARIUM Macbr.

Sporangia clavate, stalked, crowded, 1 to 1.4 millimeters high, dark red. Stalks combined in clusters of from five to ten, red. Capillitium red, twisting threads, 5.7 to 6 microns in diameter, with spiral bands and numerous scattered spines. Spores red, warted, 11 microns in diameter. Habit: On dead wood; Harbin, October, 1920. Geographic distribution: Recorded from most temperate and tropical regions; United States.

HEMITRICHIA CLAVATA Rost.

Sporangia stalked, gregarious or crowded, 0.9 to 2 millimeters high, olivaceous-yellow; sporangium wall yellow. Stalk red-brown. Capillitium a network of branched yellowish threads, 5.3 to 5.7 microns in diameter, marked with five spiral bands, without spines. Capillitium ends subclavate. Spores dark brown, warted, 7.2 to 7.6 microns in diameter. Habit: On dead wood; Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Widely distributed and common in all temperate and tropical regions.

ARCYRIA DENUDATA Wettstein.

Sporangia stalked, ovoid or cylindrical, 0.6 to 2 millimeters high, 0.4 to 1.2 millimeters broad, reddish or reddish brown. Capillitium a close elastic network of red threads with thickenings of cogs or spines and half-rings. Spores red, smooth, 6 to 7 microns in diameter. Habit: On dead wood and bark of trees; Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Abundant in temperate and tropical regions.

ARCYRIA CINEREA Pers. Plate 4, fig. 1.

Sporangia stalked, almost gregarious, cylindrical, 0.7 to 1.2 millimeters long, 0.4 to 0.7 millimeter in diameter; pale gray. Stalk 0.4 to 0.6 millimeter long, dark gray. Capillitium a close network of gray threads, warted and spinulose. Spores gray, smooth, 6 to 6.5 microns in diameter. Habit: On dead wood; Harbin, November, 1929. Geographic distribution: Common and widely distributed in temperate regions.

ARCYRIA CARNEA G. Lister.

Sporangia stalked, clustered, ovoid or shortly cylindrical, flesh-colored, 1.5 to 2 microns high; cup plaited at the base, red. Stalks black. Capillitium a close and only slightly elastic network of dark red threads, 3.7 to 4.5 microns in diameter, marked with a loose spiral of flat-tipped cogs or spines. Spores reddish, 6.8 to 7.4 microns in diameter, smooth. Habit: On dead wood; Maoershan station, Chinese Eastern Railway, August, 1928. Geographic distribution: Europe and Japan.

PERICHAENA DEPRESSA Libert.

Sporangia sessile, crowded, flattened, 0.1 to 0.5 millimeter in diameter, sometimes forming short branching plasmodiocarps of 1 to 3 millimeters diameter, purple-brown. Sporangium wall of two layers. Capillitium branched yellow threads, minutely warted. Spores yellow, warted, 9 to 11 microns in diameter. Habit: On dead bark of *Populus simonii;* Harbin, November, 1929. Geographic distribution: Widely distributed in temperate and tropical regions.

ILLUSTRATIONS

PLATE 1

FIGS. 1 to 3. *Physarum mandshuricum* sp. nov.; *1*, sporangia, × 20; *2* and *3*, capillitium and spore, × 500.

4 to 6. *Physarum griseum* sp. nov.; *4*, sporangia, × 20; *5* and *6*, capillitium and spore, × 500.

7 to 9. *Physarum compressum* sp. nov.; *7*, sporangia, × 20; *8* and *9*, capillitium and spore, × 500.

10 to 12. *Trichia asiatica* sp. nov.; *10*, sporangia, × 20; *11* and *12*, capillitium and spore, × 500.

PLATE 2

FIGS. 1 to 3. *Lepidoderma mandshurica* sp. nov.; *1*, sporangia, × 20; *2* and *3*, capillitium and spore, × 500.

4 and 5. *Licea mandshurica* sp. nov.; *4*, sporangia, × 20; *5*, spores, × 500.

6 to 8. *Badhamia mandshurica* sp. nov.; *6*, sporangia, × 20; *7* and *8*, capillitium and spore, × 500.

9 to 11. *Physarum asiaticum* sp. nov.; *9*, sporangia, × 20; *10* and *11*, capillitium and spore, × 500.

PLATE 3

FIG. 1. *Trichia persimilis* Karst., sporangia, × 15.

2. *Fuligo septica* Gmelin var. *rufa* R. E. Fries, æthalia, × 1. 5.

3. *Fuligo septica* Gmelin, æthalia, × 1. 5.

4. *Licea brassica* sp. nov., sporangia, × 10.

PLATE 4

FIG. 1. *Arcyria cinerea* Pers., sporangia, × 15.

2. *Diderma globosum* Pers., sporangia, × 15.

3. *Ceratiomyxa fruticulosa* Macbr. var. *flexuosa* Lister, sporophores, × 15.

4. *Fuligo septica* Gmelin, æthalia, × 1. 5.

PLATE 5

FIG. 1. *Hemitrichia serpula* Rost., sporangia, × 8.

2. *Lepidoderma mandshurica* sp. nov., sporangia, × 5.

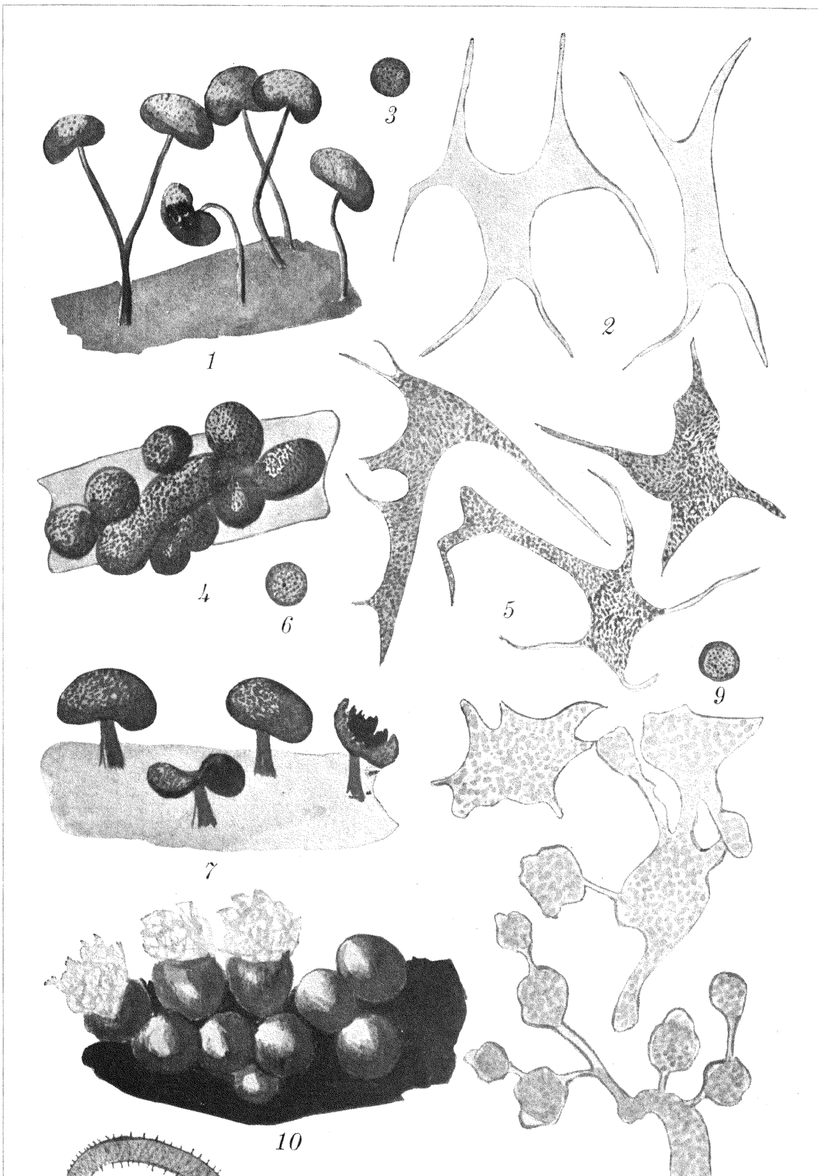

PLATE 1.

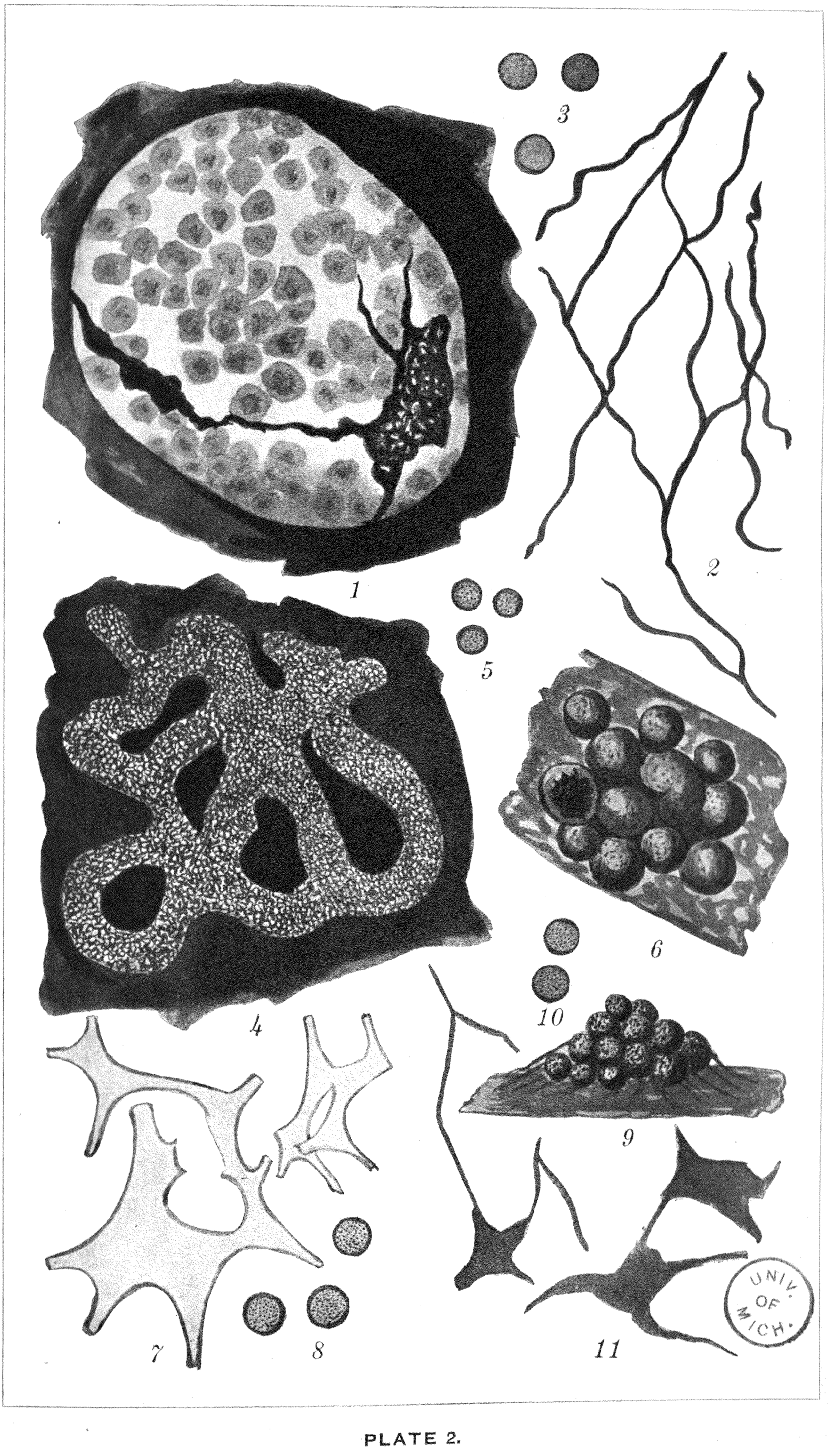

PLATE 2.

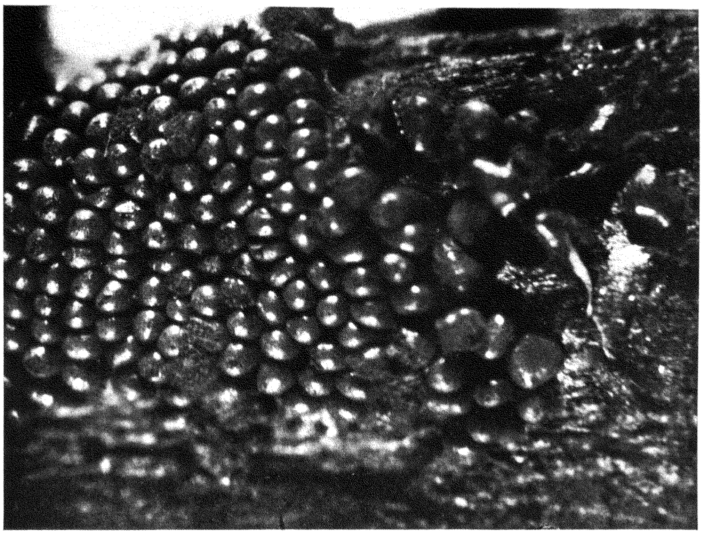

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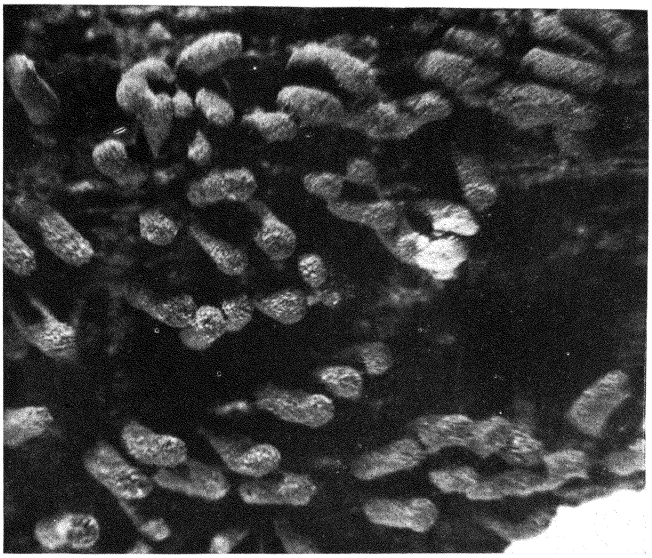
PLATE 3.



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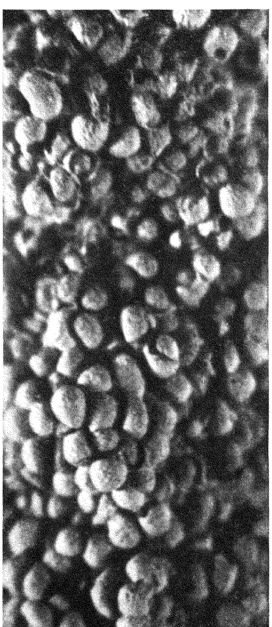

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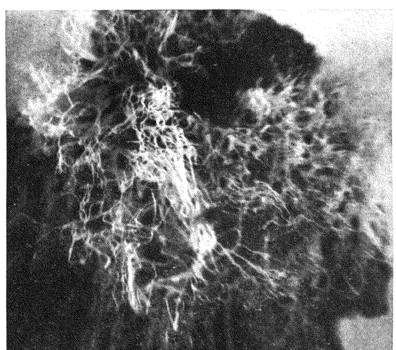

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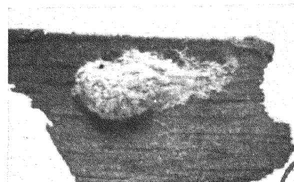

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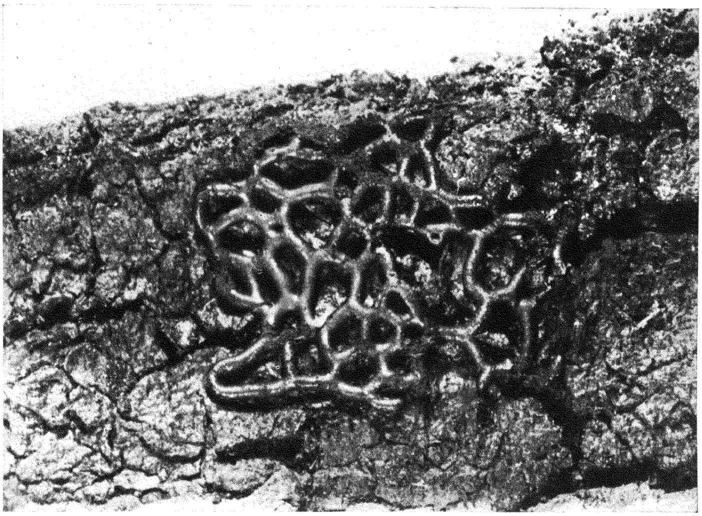
PLATE 4.



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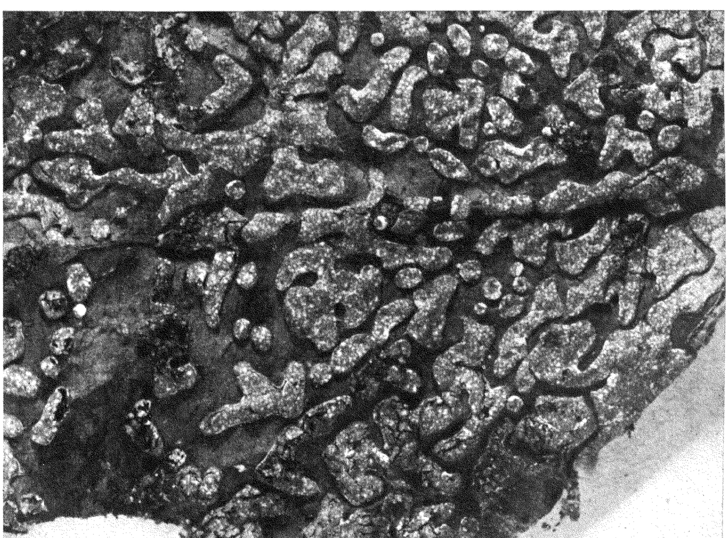

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PLATE 5.

PELAGIC DIATOMS OF KOREAN STRAIT OF THE SEA OF JAPAN

By B. W. Skvortzow

Of Harbin, China

TEN PLATES

Our knowledge of pelagic diatoms of the Pacific Ocean is still incomplete in comparison with that of the northern part of the Atlantic. A certain amount of work has been done on the marine diatoms of various parts of Japan, but most of the algæ of the Korean shores have been overlooked. Contributions on the diatoms of the Sea of Japan have been published by K. Okamura, J. Ikari, H. H. Gran, K. Yendo, B. Schroder, and F. Hustedt.

The diatoms that form the subject of this memoir were obtained from material collected by the Government Fishery Experimental Station, of Fusan, Chosen, and sent me through the kindness of Dr. Yojiro Wakiya, director of that station. The gatherings were the following:

1. Fusan, between Katokuto Island and Tatapo, January 12, 1925.
2. Port Fusan, between Fusan and Zetsueito Island, November 9, 1925.
3. Near Port Fusan, February 28, 1926.
4. Northern Tsushima Island, September 13, 1925.
5. Near Tsushima Island, February 3, 1926.

All the samples were rich in pelagic diatoms, especially in *Coscinodiscus, Rhizosolenia, Chaetoceras,* and *Stephanopyxis.* Sample 1 contained *Coscinodiscus* plankton; sample 2, a *Rhizosolenia-Chaetoceras* plankton; sample 3 was very rich in Crustacea and contained some *Coscinodiscus, Eucampia,* and *Stephanopyxis;* sample 4 was the richest in pelagic forms, especially of the genera *Stephanopyxis, Lauderia, Bacteriastrum,* and *Chaetoceras;* sample 5, collected not far from Tsushima Island, contained small *Chaetoceras.*

All these samples yielded a considerable number of diatoms, which I have described and enumerated as a contribution to the geographic distribution of this important group of marine organisms. The present list contains the names of seventy

forms, among which are some new to science. This note is illustrated with drawings by the author. The number or numbers after the comment on each species correspond to the localities given above.

COSCINODISCUS EXCENTRICUS Ehrenberg.

A. SCHMIDT, Atlas Diatom., pl. 58, figs. 46–49; V. HEURCK, Synopsis (1880–85) pl. 130, figs. 4, 7, and 8.

Diameter of valve 0.037 to 0.042 millimeter. Markings polygonal, decreasing towards the border. Apiculi distinct. Geographic distribution: Atlantic and Pacific Oceans and the Sea of Japan. Localities 1, 3, and 4.

COSCINODISCUS FRAGILISSIMUS Grunow.

GRUNOW in V. Heurck, Synopsis (1880–85) pl. 128, fig. 4.
Ethmodiscus convexus CASTRACANE, Diat. Challenger Exped. (1886) 167, pl. 3, fig. 9.

Diameter 0.085 to 0.1 millimeter (in Castracane 0.129, in Grunow 0.316 millimeter). Central space minute, indistinct. Markings forming invisible striations and minute denticules, scattered on the whole surface of the disk. Geographic distribution: Arafura Sea. Locality 1.

COSCINODISCUS CONCINNUS W. Smith. Plate 1, figs. 1–2, 4–6.

A. SCHMIDT, Atlas Diatom. (1886) pl. 114, figs. 8, 9; RATTRAY, Revision Coscin. (1889) 531; PERAGALLO, Diat. Mar. France (1897–1908) pl. 115, fig. 12.

Disk covered with radiating lines of small granules. Diameter of disk 0.13 to 0.37 millimeter. Radiating lines are separated by rows of very minute granules, which pass from as many points, disappear towards the center or form a central rosette. Several valves were found with abnormal areoles, forming a rim in the middle part or two centers. Castracane's *Coscinodiscus papuanus,* from New Guinea, and *Coscinodiscus mirificus* belong to our species. Geographic distribution: Atlantic and Pacific Oceans. Localities 1, 2, 3, and 4.

COSCINODISCUS RADIATUS Ehrenberg. Plate 1, fig. 3.

A. SCHMIDT, Atlas Diatom. pl. 60, figs. 1–6, 9, 10; pl. 61, fig. 13; pl. 65, fig. 8; pl. 113, figs. 8, 21; RATTRAY, Revision Coscin. (1889) 514.

Markings four in 0.01 millimeter, gradually decreasing towards the border. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Hong Kong, Dairen. Localities 1, 2, and 3.

PLANKTONIELLA SOL (Wallich) Schütt. Plate 9, fig. 10.

SCHÜTT, Pflanzenleb. d. Hochsee (1893) 20, fig. 8.
Coscinodiscus sol WALLICH, Trans. Micr. Soc. 8 (1860) 38, figs. 1–2.
Cestodiscus sol GRUNOW in V. Heurck, Synopsis (1880–85) pl. 12, fig. 9; A. SCHMIDT, Atlas Diatom. (1878) pl. 58, figs. 41, 42, 45; KARSTEN, Indisch. Phytopl. (1907) 369, pl. 39, figs. 1–12; HUSTEDT, Kieselalgen (1929) 465–67, fig. 259; RATTRAY, Revision Coscin. (1889) 466.

Valve flat, disklike. Length 0.052 to 0.12 millimeter. Markings distinct, in radiate rows, decreasing from the center outward. The outer portion of the valve makes a broad, scarcely siliceous disk. Geographic distribution: Common in plankton of Atlantic and Pacific Oceans, Java Sea, Sea of Japan; fossil in Cambridge and Barbados deposits. Locality 4.

ACTINIPTYCHUS UNDULATUS (Bailey) Ralfs.

A. SCHMIDT, Atlas Diatom. (1874–81) pl. 1, figs. 1–4, 6, 8, 9; pl. 29, figs. 4–8; pl. 109, fig. 1; pl. 122, figs. 1, 3; V. HEURCK, Synopsis (1880–85) pl. 122, figs. 1, 3.

Valve disklike. Length 0.025 to 0.09 millimeter. Areoles 3 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Dairen. Locality 4.

CORETHRON PELAGICUM Brun. Plate 8, fig. 14.

SCHRODER, Phytopl. warmer Meere (1906) 343, fig. 3; HUSTEDT, Kieselalgen (1929) 547, figs. 312*a*, *b*, *c*.

Cell robust, cylindrical, 0.095 to 0.115 millimeter in diameter, with rounded ends and long spines on both sides. Spines very delicate, smooth. Geographic distribution: Atlantic and Pacific Oceans; Hong Kong. Locality 4.

EUCAMPIA ZODIACUS Ehrenberg. Plate 2, figs. 5, 6.

KÜTZING, Bacillar. (1844) 143, pl. 21, fig. 21; W. SMITH, Brit. Diatom. (1853–56) 2, 25, pl. 35, fig. 299; SCHÜTT, Bacillariales (1896) 89, figs. 46A, 147B; OKAMURA, Littoral Diatoms Japan (1911) 6–7, pl. 11, figs. 33*a–d*; PERAGALLO, Diat. Mar. France (1897–1908) 376, pl. 95, fig. 2; V. HEURCK, Synopsis (1880–85) pl. 95, figs. 17–18.

Cell elliptical forming curved chain. Foramina oval. Geographic distribution: Atlantic and Pacific Oceans; Malay Archipelago; in Japanese waters known from Goza, Toshima, and Boshyu. Localities 1, 2, 3, and 4.

EUCAMPIA BICONCAVA (Cleve) Ostenfeld. Plate 2, fig. 9.

OSTENFELD, Flora Koh Chang, Mar. Plank. Diat. (1902) 23.
Eucampia hemiauloides OSTENFELD in Ostenfeld and Schmidt, Plankton Rode Hav og Adenbugten (1901) 157–58, fig. 8.

Climacodium biconcavum CLEVE, Phytoplank. (1897) 22, pl. 2, figs. 16, 17; OKAMURA, Littoral Diatoms Japan (1911) 8, pl. 11, fig. 35.

C. H. Ostenfeld gives the following description of this alga:

Chain straight, cells slightly siliceous, nearly as long as wide (length 0.04 to 0.06 millimeter, width 0.035 to 0.065); side view elliptic; front view symmetrical on both sides of the longitudinal axis; processes of the valves short; valves membraneous; connecting zone very finely annulated. Chromatophores numerous disciform.

Geographic distribution: Atlantic and Pacific Oceans, Mediterranean and Red Seas, Gulf of Aden, Malay Archipelago; Sea of Japan, Zenidzu. Locality 4.

STEPHANOPYXIS TURRIS (Greville and Arnott) Ralfs. Plate 2, fig. 4.

PRITCHARD, Infusor. (1861) 826, pl. 5, fig. 74; A. SCHMIDT, Atlas Diatom. (1888) pl. 130, figs. 42, 43.

Stephanopyxis appendiculata EHRENBERG, in Microgeol. (1854) pl. 18, fig. 4; HUSTEDT, Kieselalgen (1928) 304–306, fig. 140.

Cell cylindrical, with rounded ends, 0.03 to 0.045 millimeter in breadth and 0.074 to 0.085 in length. The surface is densely cellular. Geographic distribution: Atlantic and Pacific Oceans; known from Japanese waters. Localities 3 and 4.

STEPHANOPYXIS PALMERIANA (Greville) Grunow. Plate 2, figs. 1, 2.

GRUNOW, Diatomeen Franz Josefs-Land (1884) 90.

Stephanopyxis var. *javanica* GRUNOW in A. Schmidt, Atlas Diatom. pl. 130, fig. 44.

Stephanopyxis palmeriana var. *japonica* in OKAMURA, Littoral Diatoms Japan (1911) 2, pl. 8, fig. 2; GRAN and YENDO, Japan. Diatoms (1914) 26–27.

Stephanopyxis campana CASTRACANE, Diat. Challenger Exped. (1886) 88, pl. 19, fig. 14; KARSTEN, Indisch. Phytopl. (1907) pl. 54, figs. 9*a*, *b*; HUSTEDT, Kieselalgen (1928) 308–9, figs. 147*a–d*.

Cells cylindrical, 0.045 to 0.135 millimeter in diameter, forming a long chain. Cells covered with areoles, large in the upper part and small in the middle part of the cell. Geographic distribution: Atlantic and Pacific Oceans. Hong Kong; in Japanese waters known from Shinojima, Shirahama, Goza, Mizaki, Misumi, Yenoshima, Akashi Channel, and Yeddo Bay. Localities 3 and 4.

STEPHANOPYXIS PALMERIANA forma CURTA forma nov. Plate 2, fig. 3.

Valve flat, 0.105 to 0.12 millimeter broad and 0.04 to 0.045 in length. Localities 3 and 4.

THALASSIOSIRA HYALINA (Grunow) Gran. Plate 2, fig. 10.

GRAN, Biblioth. Botan. 42 (1897) 4, pl. 1, figs. 17, 18.

Coscinodiscus hyalinus GRUNOW, Kongl. Sv. Vet. Akad. Handl. 17, No. 2 (1884) 113, pl. 7, fig. 128.

Thalassiosira clevei GRAN, Norske Nordh. Exped. Bot. Protoph. (1897) 29, pl. 4, figs. 60–62; PERAGALLO, Diat. Mar. France (1908) 438, pl. 120, fig. 9.

Thalassiosira gravida CLEVE in Okamura, Littoral Diatoms Japan (1911) 2, pl. 8, fig. 3; HUSTEDT, Kieselalgen (1928) 323–24, fig. 159.

A pelagic diatom forming a long chain composed of flat cells. Our plant has cells 0.045 to 0.052 millimeter in diameter. According to J. Rattray (1889):

Diameter of the valve is 0.025 millimeter. Central space minute, inconspicuous, bearing isolated puncta. Markings punctiform, subequal, 24 in 0.01 millimeter, rows radial to subparallel in inconspicuous fasciculi; apiculi numerous, distinct, in a single circlet. Border broad, hyaline.

Geographic distribution: Atlantic and Pacific Oceans. Locality 4.

LAUDERIA BOREALIS Gran. Plate 2, fig. 11.

GRAN, Nyt. Mag. f. Naturvid. **38** (1900) 110, pl. 2, figs. 5–9.

Lauderia annulata CLEVE, Diatoms of Sea of Java (1873) 8, pl. 1, fig. 7.

Lauderia compressa PERAGALLO, Diatom. Mar. France (1897–1908) pl. 121, fig. 2.

Thalassiosira nordenskioldii CLEVE in Okamura, Littoral Diatoms Japan (1911) 2, pl. 8, fig. 4; HUSTEDT, Kieselalgen (1928) 549–50.

Chain composed of cylindrical frustule, orbicular in side view, near the margin covered with numerous short, hairlike spines. Sculpture consists of very fine puncta. Geographic distribution: Atlantic and Pacific Oceans; in Japanese waters known from Shirahama. Localities 1, 3, and 4.

SCHROEDERELLA DELICATULA (Peragallo) Pavillard. Plate 2, fig. 13.

PAVILLARD, Obser. Diat. (1913) 60, 126.

Lauderia delicatula PERAGALLO, Bull. Soc. Hist. Nat. Toulouse (1888) 22, 81, pl. 6, fig. 46.

Lauderia delicatula PERAGALLO, Diat. Mar. France (1897–1908) pl. 121, figs. 4, 8, 9.

Lauderiopsis costata OSTENFELD, in Ostenfeld and Schmidt, Plankton Rode Hav. og Adenbugten (1901) 158–59, fig. 10.

Detonula schroederi GRAN, Nord. Plankton (1906) 22; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 320, figs. 16–17; pl. 321, fig. 4; Kieselalgen (1929) 551–53, fig. 314.

Chain straight, composed of many cylindrical cells 0.025 to 0.04 millimeter broad, rectangular in front view. Geographic distribution: Common in Atlantic and Pacific Oceans. Locality 4.

LEPTOCYLINDRUS CURVATUS sp. nov. Plate 2, fig. 14.

Cell cylindrical, rectangular in front view, 0.004 to 0.0045 millimeter broad, 0.007 to 0.008 in length. Chromatophores numerous. Locality 4.

DITYLIUM BRIGHTWELLII (West) Grunow. Plate 2, figs. 7, 8.

V. HEURCK, Synopsis (1880–85) pl. 114, figs. 3–9; Traite Diatom. (1889) 424, pl. 17, fig. 606; A. SCHMIDT, Atlas Diatom. pl. 152, figs. 10–13; PERAGALLO, Diatom. Mar. France (1897–1908) 395–96, pl. 96, figs. 6–11; SCHRÖDER, Phytopl. Antarkt. Meeres (1906) 353–55, figs. 22*a–c*.

Ditylium sol V. HEURCK in Okamura, Littoral Diatoms Japan (1911) 8, pl. 11, fig. 37.

A plankton species with a peculiar triangular valve with two long horns from both sides. Geographic distribution: Atlantic and Pacific Oceans; in the Sea of Japan known from Tateyama, Shirahama, Shima, Misaki, and Hong Kong. Localities 2 and 4.

CHAETOCERAS LORENZIANUM Grunow. Plate 3, fig. 4.

GRUNOW, Osterreich. Diatom. (1864) 157, pl. 5, fig. 13; V. HEURCK, Synopsis (1880–85) pl. 82, fig. 2; CLEVE, Diatom. Arctic Sea (1897) 21, pl. 1, figs. 13–15; GRAN, Nord. Plankton (1906) 76, fig. 90; OKAMURA, Chaetoceras and Peragallia (1907) 93, pl. 4, figs. 38–39; Littoral Diatoms Japan (1911) 7, pl. 11, fig. 31.

Chaetoceras cellulosum LAUDER, Diatom. Hong Kong (1864) 78, pl. 8, fig. 12; GRAN and YENDO, Japan. Diatoms (1914) 9; PERAGALLO, Diatom. Mar. France (1897–1908) 484, pl. 131, figs. 1–3; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 321, figs. 18–19; pl. 322, fig. 1.

Cells forming a straight chain 0.008 to 0.012 millimeter broad. Cell rectangular with projecting angles. Foramina large, broad elliptic or quadrangular with round angles. Setæ thin, their basal parts almost parallel to the chain axis. Terminal setæ rather well differentiated and disposed parallel or more or less divergent. Geographic distribution: Atlantic and Pacific Oceans; in Japanese waters known from Boshu, Misaki, Enoshima, Akashi, and Formosa Channel. Localities 2, 4, and 5.

CHAETOCERAS JAVANICUM Cleve. Plate 3, fig. 2.

CLEVE, Diatoms Sea of Java (1873) 11, pl. 2, fig. 13; PERAGALLO, Diatom. Mar. France (1897–1908) 480, pl. 130, figs. 1, 2; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 323, figs. 1, 2.

Cells forming a straight chain 0.02 to 0.04 millimeter broad. From the front view the cell is rectangular with projecting angles. Foramina large, broad elliptic; setæ thin, with their basal parts almost parallel to the chain axis. Terminal setæ parallel or more or less divergent. Chromatophore single.

Geographic distribution: Indian Ocean and Sea of Japan. Localities 2, 4, and 5.

CHAETOCERAS SIAMENSE Ostenfeld. Plate 3, fig. 3.

OSTENFELD, Flora Koh Chang (1902) 21, fig. 17.

Chaetoceras lauderi RALFS var. in Lauder, Diatom. Hong Kong (1864) 77, pl. 8, fig. 3.

Chaetoceras misumense GRAN and YENDO, Japan. Diatoms (1914) 14–15, fig. 7;. IKARI, Chaetoceras Japan. (1928) 257–58, fig. 11.

I quote the diagnosis of Gran and Yendo, as follows:

The frustules are quadrangular, measuring 0.02 to 0.03 millimeter in breadth, and 0.02 to 0.04 millimeter in height, and are elliptical in a valvar view. The setae spring directly from the corners of the valves, at first diverging and then gradually bending in a direction parallel to the axis of the chain. Their terminal half is armed with minute spinous processes arranged spirally. The terminal horns have a similar direction to that of the setae, but bent more abruptly near the points of insertion and then run almost straight out, forming an acute angle with one another. The two horns are in one plane. They are more robust than the setae, and like them are beset with minute processes. The foramen is elliptical or broadly lanceolate in a surface view, but practically narrow lanceolate in an optical section. There are two peculiar depressions in the middle of each valve, as shown by Lauder. The girdle-bands become much narrowed about the middle of the complanate side of the frustules. The resting spores have pallisade spines on the margins of both the primary and the secondary valve. The primary valve is almost hemispherical, and has numerous short spines over its whole surface; the secondary valve is nearly similar, but is somewhat humped and has short spines condensed about the summit.

The Korean specimens were without spores. Geographic distribution: Sea of Japan (Kushimoto, Seto, Misumi), South China Sea, Hong Kong. Localities 2 and 5.

CHAETOCERAS BOREALE Bailey. Plate 3, fig. 1.

BAILEY, Notes Microscop. Organ. (1854) 8, figs. 22–23.

Chaetoceras boreale var. *brightwellii* CLEVE, Diat. Arctic Sea (1873) 12, fig. 7*a*.

Chaetoceras boreale CLEVE, Treatise Phytopl. N. Atlantic (1897) 20, pl. 1, fig. 1.

Chaetoceras boreale var. *brightwellii* CLEVE, Treatise Phytopl. N. Atlantic (1897) 20, pl. 1, fig. 2; PERAGALLO, Diatom. Mar. France (1897–1908) 476–77, pl. 127, figs. 2, 3; OKAMURA, Chaetoceras and Peragallia Japan (1907) 90, pl. 3, figs. 18–20; GRAN, Diatom. Arkt. Meere (1904) 533, fig. 5; Nord. Plankton (1906) 73, fig. 87; GRAN and YENDO, Japan Diatom. (1914) 7; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 325, figs. 5, 6.

Chain straight, 0.025 to 0.04 millimeter broad. Cells in front view quadrangular with rounded angles, shorter than the

breadth. Girdle band attains over one-third of the cell height. Valve convex. Foramina small and rhomboidal. Setæ start direct from these cones and each then coalesces with that of the neighboring cell within the lateral sides of the chain. Setæ adorned with spines. Geographic distribution: Common in northern seas, Atlantic and Pacific Oceans; known from Japanese waters from Tateyama and Misaki. Localities 2, 3, and 4.

CHAETOCERAS REICHELTI Hustedt. Plate 7, fig. 2.

HUSTEDT in A. Schmidt, Atlas Diatom. (1921) pl. 344, fig. 6.

Chain straight, composed of 3 or 4 cells, 0.02 to 0.03 millimeter broad. Cells in front view quadrangular, twice longer than breadth. Girdle band about one-half of the mantle height. Setæ long, punctate, issuing from the angles of the valves, crossing each other, leaving short basal parts and diverging at an obtuse angle. Terminal setæ nearly parallel to the chain axis or somewhat divergent from each other. Geographic distribution: See Adler-Hafen collected by Cohn in 1912. Locality 4.

CHAETOCERAS IKARI sp. nov. Plate 7, fig. 1.

Chain straight 0.008 to 0.015 millimeter broad, composed of five to twenty cells. Frustules rectangular elongate, three to four times as long as the breadth, with sharp projecting angles. Valve concave or sometimes flat. Foramina large, broad, elliptic. Setæ thin, issuing from the angles of the valves, diverging at an obtuse angle. Chromatophore single. Named in honor of the well-known Japanese diatomist I. Ikari, Seto Biological Station, Japan. Localities 2 and 4.

CHAETOCERAS SOCIALE Lauder. Plate 5, fig. 7.

LAUDER, Diatom. Hong Kong (1864) 77, pl. 8, fig. 1; CLEVE, Diatoms Baffin Bay (1896) 9, pl. 2, fig. 9; GRAN, Bacillar. Karajakfjord (1897) 26, pl. 4, fig. 54; Nord. Plankton (1906) 96, fig. 123; GRAN and YENDO, Japan. Diatoms (1914) 24; OKAMURA, Littoral Diatoms Japan (1911) 7, pl. 11, fig. 30; PERAGALLO, Diatom. Mar. France (1897–1908) 490, pl. 132, figs. 1–3.

Cells slender, aggregated, embedded in gelatine. Chain composed of three to five cells. Valves broadly oval and flat, in front view rectangular. Setæ very delicate, thin, straight, curved or undulated. The chromatophore single. Geographic distribution: Arctic Sea, Atlantic and Pacific Oceans; known from Japanese waters from Boshu Province, Volcano Bay, Mi-

saki, Otaru Bay, Euoshima, and Akashi. Localities 1, 2, 4, and 5.

CHAETOCERAS PROTUBERANS Lauder. Plate 5, fig. 4.

LAUDER, Diatom. Hong Kong (1864) 79, pl. 8, fig. 11.

Chaetoceras didymum in OKAMURA, Chaetoceras and Peragallia (1907) 95, pl. 4, fig. 45*a*; GRAN and YENDO, Japan. Diatoms (1914) 12–13, fig. 5; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 326, figs. 1, 5.

Cells forming a long chain, 0.005 to 0.008 millimeter broad. Cell oblong with mamilliform protuberance. Setæ long, spinose, coalesced. Terminal setæ well developed, curved, with spirally disposed punctations. Geographic distribution: Atlantic and Pacific Oceans; in Japanese waters known from Shima Province, Misaki, Otaru Bay, and Misumi. Localities 2, 4, and 5.

CHAETOCERAS DIDYMUM Ehrenberg var. **ANGLICA** Gran. Plate 5, fig. 6.

GRAN, Nord. Plankton, (1906) 80, fig. 95; OKAMURA, Chaetoceras and Peragallia (1907) 95, pl. 4, figs. 44–47, excl. fig. 45*a;* V. HEURCK, Synopsis (1880–85) pl. 82, fig. 3.

Chaetoceras didymum var. *longicruris* CLEVE, Phytopl. (1897) 21, pl. 1, fig. 11; PERAGALLO, Diatom. Mar. France (1897–1908) 481, pl. 128, fig. 3; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 326, figs. 3, 4.

Cells forming a straight chain, 0.025 to 0.03 millimeter broad, sometimes composed of twenty or more cells. Cells quadrangular or elliptical, convex in the middle, forming a large dot. Setæ arise from within the angles curved. Geographic distribution: In Japanese waters found in Shima Province, Misaki, Misumi, Enoshima, and Formosa Channel. Localities 2, 4, and 5.

CHAETOCERAS DIDYMUM Ehrenberg var. **GENUINA** Gran. Plate 5, figs. 3 and 5.

GRAN, Nord. Plankton (1906) 79, fig. 94; GRAN and YENDO, Japan. Diatoms (1914) 12–13; OKAMURA, Chaetoceras and Peragallia (1907) 95, pl. 4, figs. 44–47, excl. fig. 45*a;* HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 326, figs. 2, 7; PERAGALLO, Diatom. Mar. France (1897–1908) 480–81, pl. 128, figs. 1, 2.

Cells forming a straight chain 0.03 to 0.055 millimeter broad, composed of many cells. Cells broad elliptical, convex in the middle. Setæ starting from the angles of the valve, crossing one another close to their insertions, diverging at an obtuse angle. Terminal setæ well developed, robute, straight. Geographic distribution: Atlantic and Pacific Oceans; known from

Japanese waters from Tosa Province, Misumi, Enoshima, and Akashi. Localities 2, 3, 4, and 5.

CHAETOCERAS RADIANS Schütt. Plate 5, fig. 2.

SCHÜTT, Chaetoceras und Peragallia (1895) 41, figs. *10a–c;* PERAGALLO, Diatom. Mar. France (1897–1908) 490–91, pl. 133, fig. 4; GRAN, North Polar Exped. (1900) 26; Nord. Plankton (1906) 97, fig. 124.

Cell forming a spiral and curved chain, 0.008 to 0.01 millimeter broad. Cell small in front view, rectangular. Foramina oblong or hexagonal. Setæ only on one side, straight, thin. Chromatophore single. Geographic distribution: Atlantic and Pacific Oceans. Localities 4 and 5.

CHAETOCERAS DECIPIENS Cleve. Plate 6, figs. 3 and 4.

CLEVE, Diatoms Arctic Sea (1873) 11, fig. 5; GRAN, Protoph., Diatom., etc. (1897) 13, pl. 1, figs. 2, 3; pl. 3, figs. 3, 4; Diatom. Arkt. Meere (1904) 535–38, pl. 17, figs. 1–6; GRAN and YENDO, Japan. Diatoms (1914) 8–9, figs. *3a, b;* PERAGALLO, Diatom. Mar. France (1897–1908) 485, pl. 131, figs. 4–8.

Chaetoceras grunowii SCHÜTT, Chaetoceras und Peragallia (1895) 43, figs. 14*a*, *b*.

Cells forming a straight chain, rectangular in a broader front, with round or somewhat projecting angles. Valves broad elliptic, convex in the middle. Foramina elongate, slightly constricted in the middle. Basal parts of the setæ parallel to chain axis, then parallel or diverging at an obtuse angle. Terminal setæ diverging in a variable angle. The terminal and the lateral setæ are clearly punctated, but in some chains such markings are entirely lacking. Chromatophores numerous. Geographic distribution: Very common in Atlantic and Pacific Oceans; in Japanese waters found at Otaru Bay, Echigo Province, Misumi, and Enoshima. Localities 2, 4, and 5.

CHAETOCERAS COMPRESSUM Lauder. Plate 5, fig. 1.

LAUDER, Diatom. Hong Kong (1864) 78, pl. 8, fig. 6; CLEVE, Plankton. Ciliof. och. Diatom. (1894) 12, pl. 2, fig. 3; SCHÜTT, Chaetoceras und Peragallia (1895) 43, figs. 16, *a, b;* OSTENFELD, Flora Koh Chang (1902) 94, pl. 3, figs. 8–11.

Chaetoceras contortum SCHÜTT, Diatom. Chaetoceras (1888) pl. 3, fig. 4.

Chaetoceras medium SCHÜTT, Chaetoceras und Peragallia (1895) 43, fig. 15; GRAN, Bacillar. Karajakfjord. (1897) 14, pl. 2, fig. 32; GRAN and YENDO, Japan. Diatoms (1914) 10, figs. *4a–d;* PERAGALLO, Diatom. Mar. France (1897–1908) 488–89, pl. 134, fig. 8.

Chain straight or slightly curved when composed of many cells, 0.016 to 0.024 millimeter broad. Foramina oblong or constricted

in the middle part. Lateral view of valve compressed oval. Setæ arise from a little within the angles, long, robust, with strong undulations and with verrucose dots small and very thin. Geographic distribution: A well-distributed species known from the Sea of Japan, Volcano Bay, Echigo Province, Misaki, Yeddo Bay, Misumi, Tateyama, Enoshima, Akashi, and Formosa Channel. Localities 2, 4, and 5.

CHAETOCERAS TORTISSIMUM Gran. Plate 6, fig. 2.

GRAN, Nord. Plankton (1906) 95–96, fig. 122; PAVILLARD, Danish Ocean. Exped. (1925) 52, fig. 87; IKARI, Chaetoceras of Japan (1928) 532–33, figs. 5*a*, *b*.

Chain straight or curved. Cells in front view rectangular, with some rounded angles. Setæ delicate, thin, smooth, most perpendicular to the chain axis. Chromatophores solitary. Geographic distribution: Atlantic and Pacific Oceans; Sea of Japan at Seto and Oshoro. Locality 5.

CHAETOCERAS ATLANTICUM Cleve. Plate 7, figs. 3–5.

CLEVE, Diat. Arctic Sea (1873) 11, pl. 2, fig. 8; GRAN, Nord. Plankton (1906) 64, fig. 74; GRAN and YENDO, Japan. Diatoms (1914) 3–5, fig. 1; KARSTEN, Phytopl. Antark. Meere (1905–6) 115, pl. 15, fig. 9; OKAMURA, Chaetoceras and Peragallia (1907) 89, pl. 4, figs. 56–62.

Chaetoceras atlanticum var. *tumescens* GRUNOW in V. Heurck. Synopsis (1880–85) pl. 81, fig. 6.

Chaetoceras dispar CASTRACANE, Diatom. Challenger Exped. (1886) 76, pl. 8, fig. 6.

Chaetoceras compactum SCHÜTT, Chaetoceras und Peragallia (1895) 46, fig. 23.

Chaetoceras skeleton SCHRÖDER, Phytopl. warm. Meere (1906) 337.

Chain straight and composed of many cells. Cells in front view quadrangular or, frequently, much compressed; shorter than the breadth. Girdle band about one-third of the mantle height. Setæ long, smooth, curved. Geographic distribution: Atlantic and Pacific Oceans; in Japanese waters known from Tosa, Kuriles, Enoshima, Volcano Bay, and Otaru Bay. Locality 4.

CHAETOCERAS DADAYI Pavillard. Plate 6, fig. 1.

PAVILLARD, Observ. Diatoms (1913) 131–33, fig. 2; Danish Ocean. Exped. (1925) 41, figs. 54*b*; IKARI, Chaetoceras of Japan (1926) 519–20, figs. 2*c*, *d*.

Chain straight, composed of five or more cells, 0.025 to 0.04 millimeter broad. Frustules in front view rectangular with rounded angles. Foramina very narrow or indistinct. Setæ

issuing from the margin, long and thickened, with densely disposed spines. Terminal setæ not differentiated. Chromatophores small, numerous, and passing into the setæ. Geographic distribution: Atlantic and Pacific Oceans, Mediterranean Sea, Sea of Japan, Seto. Locality 4.

CHAETOCERAS PERUVIANUM Brightwell. Plate 4, figs. 4, 5.

BRIGHTWELL, Filam. longhorned Diatom. (1856) 107, figs. 16, 17; CLEVE, Diatoms of Sea of Java (1873) 8, pl. 2, fig. 8; KARSTEN, Phytopl. Antark. Meere (1905) 166, pl. 31, fig. 4; OKAMURA, Chaetoceras and Peragallia (1907) 91, pl. 4, figs. 67–75; PERAGALLO, Diatom. Mar. France (1897–1908) 475, pl. 125, fig. 1.

Peragallia meridiana SCHÜTT, Chaetoceras und Peragallia (1895) 48, figs. 28*a*, *b*.

Cells solitary, or forming a very short filament composed of two to four cells, 0.015 to 0.025 millimeter broad. Cells from front view quadrangular or elongated with rounded angles. The elongated cells have a transversal costation, sometimes zigzag in the middle part. Valve convex. Setæ very robust, straight, curved, covered with solid spines and transversely very thinly striated. Chromatophores small, round, numerous. A chain-forming *Peragallia meridiana* Schütt, Iiro Ikari describes as *Chaetoceras okamurai* Ikari. Geographic distribution: Atlantic, Indian, and Pacific Oceans; in Japanese waters found in Tosa Province, Shima Province, Misaki, Enoshima, Akashi, and Seto. Localities 2, 4, and 5.

CHAETOCERAS SALTANS Cleve. Plate 4, fig. 3.

CLEVE, Phytopl. N. Atlantic (1897) 22, pl. 1, fig. 8; PERAGALLO, Diatom. Mar. France (1897–1908) 476, pl. 126, fig. 1.

Cells solitary, 0.015 to 0.018 millimeter broad, from the front view quadrangular, with rounded angles. Girdle band narrow. Setæ robust and spinulose. Related to *Chaetoceras peruvianum* Brightw. and somewhat to *Chaetoceras criophilum* f. *volans* (Schütt) Gran. Geographic distribution: Atlantic and Pacific Oceans. Locality 4.

CHAETOCERAS AFFINE Lauder. Plate 4, fig. 2.

LAUDER, Diatom. Hong Kong (1864) 78, pl. 8, fig. 5.

Chaetoceras ralfsii CLEVE, Diatoms of Sea of Java (1873) 10, pl. 3, fig. 15.

Chaetoceras ralfsii CLEVE in Karsten, Phytopl. Antarkt. Meere (1906) 168–69, pl. 33, figs. 17–18.

Chaetoceras schüttii CLEVE, Plankton., Ciliof. och Diatom. (1894) 14, pl. 1, fig. 1.

Chaetoceras distichum SCHÜTT, Chaetoceras und Peragallia (1895) 37, figs. 2*a*, *b*.

Chaetoceras angulatum SCHÜTT, Chaetoceras und Peragallia (1895) 37, figs. 1*a–d*.

Chaetoceras procerum SCHÜTT, Chaetoceras und Peragallia (1895) 38, fig. 3*a*, *b*; PERAGALLO, Diatom. Mar. France (1895–1908) 478–79, pl. 129, fig. 3.

Cells forming a straight chain, 0.015 to 0.024 millimeter broad, composed of five to fifteen cells. Frustules in a broad front quadrangular with somewhat pointed angles. Foramina narrowly lanceolate, slightly constricted in the middle. Setæ all alike, smooth, disposed in a valval view at about right angles with one another. Terminal setæ well developed, curved, hornlike, with minute elevations spirally disposed. Chromatophore is one large plate, parietally in each cell. Resting spores 0.018 to 0.03 millimeter in diameter, primary valve nearly hemispherical with short spines all over the surface. Secondary valve greatly convex with long spines on the middle part.

According to Gran and Yendo, *Chaetoceras affine* is extremely variable in its form and in Japanese waters two types were found, one with rectangular, another with narrow, subcylindrical frustules. The terminal horns are less curved or divergent. Geographic distribution: *Chaetoceras affine* is widely distributed in the warmer parts of the Atlantic, Indian, and Pacific Oceans; in Japanese waters it has been recorded at Boshu Province, Shima Province, Enoshima, Akashi, Yeddo Bay, and Misaki. Localities 2, 4, and 5.

CHAETOCERAS MESSANENSE Castracane. Plate 4, fig. 1.

CASTRACANE, Contrib. Fl. Mediter. (1875) 32, pl. 1, fig. 1.

Chaetoceras sp. in LAUDER, Diatom. Hong Kong (1864) pl. 3, fig. 8.

Chaetoceras furca CLEVE, Phytopl. N. Atlantic (1897) 21, pl. 1, fig. 10.

Chaetoceras furca CLEVE in Karsten, Phytopl. Antark. Meere (1905) 169, pl. 32, figs. 13 *a*, *b*.

Chaetoceras furca Cleve var. *macroceras* SCHRÖDER in Okamura, Chaetoceras and Peragallia (1907) 99, pl. 3, fig. 7; GRAN, Nord. Plankton (1906) 87, fig. 108; PERAGALLO, Diatom. Mar. France (1897–1908) 488, pl. 129, fig. 1; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 322, figs. 4 and 7; pl. 325, fig. 3.

Chain straight, 0.011 to 0.028 millimeter wide and 0.1 to 0.15 in length. Cells in front view rectangular with projecting angles, valves concave, foramina lanceolate. Girdle band rather longer than about a half of the cell height. Setæ of two types. One type is thin, short, starting from the angles of the valve, crossing one another close to their insertions, diverging at an obtuse angle. The other is robust, furcate at the end with

spirally disposed punctations. Terminal setæ not differentiated, short, simple. Chromatophore solitary. Locality 5.

BACTERIASTRUM VARIANS Lauder. Plate 8, figs. 1, 3, 5–7.

LAUDER, Diatom. Hong Kong (1864) 6, figs. 1–5; KARSTEN, Phytopl. Antark. Meere (1905) 170, pl. 34, fig. 1; PERAGALLO, Diatom. Mar. France (1897–1908) 470, pl. 136, fig. 1–5.

Chaetoceras varians (Lauder) V. HEURCK, Synopsis (1880–85) 195, pl. 70, figs. 3–5.

Bacteriastrum spirillum CASTRACANE, Diatom. Challenger Exped. (1886) 83, pl. 19, fig. 2; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 328, figs. 1–5 and 11; IKARI, Bacteriastrum of Japan (1927) 421–22, fig. 1.

Chain straight, composed of many cells. Frustules cylindrical, with ten to fourteen furcated setæ covered with thin undulations. Terminal horns ten, curved at the ends and covered with spiral markings. Geographic distribution: Atlantic and Pacific Oceans; known from the Japanese waters of Oshoro, Hakodate, Seto, Kushimoto, Takashima, and Goza. Localities 2, 3, and 5.

BACTERIASTRUM HYALINUM Lauder. Plate 8, fig. 2.

LAUDER, Diatom. Hong Kong (1864) 6, pl. 3, figs. 7*a*, *b*.

Bacteriastrum spirillum CASTRACANE, Diatom. Challenger Exped. (1886) 83, pl. 24, fig. 1.

Bacteriastrum varians var. *hyalina* LAUDER in Peragallo, Diatom. Mar. France (1897–1908) 470, pl. 136, fig. 6; PAVILLARD, Observ. Diatoms (1916) 27, pl. 1, fig. 4; Danish Oceanogr. Exped. (1925) 37, fig. 58; IKARI, Bacteriastrum of Japan (1927) 422–23, fig. 2.

According to Ikari this species has—

Chain straight and composed of many cells. Foramina not very large. Length of the cell is about equal to, but generally a little shorter than the breadth (diameter 0.013 to 0.056 millimeter). Setæ, from 7 to 25 in number. Intermediate ones unite one another to form radial rays of nearly equal length to or at least a half of the diameter of the cell. The mode of bifurcation is greatly different from the preceding species; the plane which involves the furcated parts, is placed parallel to the chain axis, giving a very spiny appearance to the chain. The terminal horns are gradually curved and bent downwards, and show spiral undulations on them. Chromatophores numerous and small, the resting nucleus is situated in the center of the cell.

Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Seto, Kushimoto, Enoshima, and Akashi. Localities 2, 4, and 5.

BACTERIASTRUM MINUS Karsten. Plate 8, fig. 4.

KARSTEN, Phytopl. Antark. Meere (1905) 171, pl. 33, fig. 21.

Bacteriastrum hyalinum LAUDER in Okamura, Littoral Diatoms Japan (1911) 6, pl. 10, fig. 28; IKARI, Bacteriastrum of Japan (1927) 426–27, fig. 6.

Chain straight, composed of many cells. Frustules disklike, 0.018 to 0.025 millimeter in diameter. Intermediate and terminal setæ short and delicate, directed obliquely outwards to the chain axis. Geographic distribution: Atlantic and Pacific Oceans; in Japanese waters known from Oshoro, Hakodate, Tateyama, Kashimoto, Seto, Takashima, and Goza. Locality 4.

BACTERIASTRUM COMOSUM Pavillard var. **HISPIDA** (Castracane) Ikari. Plate 8, fig. 8.

IKARI, Bacteriastrum of Japan (1927) 428–29, fig. 8*b*.

Bacteriastrum wallichi Ralfs. var. *hispida* CASTRACANE, Diatom. Challenger Exped. (1886) 83, pl. 29, fig. 6.

Bacteriastrum varians Lauder var. *hispida* (Castr.) SCHRÖDER in Schröder, Phytopl. Warm. Meere (1906) 347, fig. 11.

Bacteriastrum varians var. *hispida* in OKAMURA, Littoral Diatoms Japan (1911) 7, pl. 10, figs. 29 *f–g;* HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 328, fig. 12.

Chain straight, composed of many cells. Frustules cylindrical, valve flat. Intermediate setæ long, furcate, curved. Terminal setæ distinct, robust, hornlike, undulated and covered with short spines. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Seto, and Kushimoto. Localities 2 and 4.

BIDDULPHIA SINENSIS Greville. Plate 8, fig. 9.

GREVILLE, Trans. Micr. Soc. (1866) 81, pl. 9, fig. 16; OSTENFELD and SCHMIDT, Plank. Rode Hav og Adenbugten (1901) 152, fig. 6; Flora Koh Chang (1902) 25, fig. 21; CLEVE, Diatoms of Sea of Java (1873) 6; A. SCHMIDT, Atlas Diatom. (1888) pl. 122, figs. 22, 23, 24; LEUDUGER-FORTMOREL, Diatomees Malaisie (1892) 39.

A large pelagic *Biddulphia* with very fine striation. Valve robust, 0.2 to 0.27 millimeter broad and 0.5 to 0.7 millimeter in length. Geographic distribution: Red Sea, Malay Archipelago, Java Sea, South China Sea, Norway, and Sea of Japan. Locality 4.

BIDDULPHIA AURITA Brébisson var. **ORIENTALIS** Mereschkowsky.

MERESCHKOWSKY, Polynesian Diatoms (1900–1902) 119; A. SCHMIDT, Atlas Diatom. pl. 120, figs. 5, 6; SKVORTZOW, Marine Diatoms Dairen (1929) 420; Marine Diatoms Siberian Shore (1929) 59, fig. 15.

Frustules without spines, 0.042 to 0.051 millimeter in length and 0.018 to 0.037 in breadth. Geographic distribution: Com-

mon in littoral zone in Pacific and Atlantic Oceans, Polynesian, Sea of Japan, and Bay of Bengal. Localities 1 and 2.

BIDDULPHIA PULCHELLA Gray. Plate 2, fig. 12.

W. SMITH, Brit. Diatom. (1853–56) pl. 44, fig. 321; A. SCHMIDT, Atlas Diatom., pl. 118, figs. 26–33; V. HEURCK, Synopsis (1880–85) pl. 97, figs. 1–3; PERAGALLO, Diatom. Mar. France (1897–1908) 376–77, pl. 93, figs. 1, 2.

Biddulphia biddulphiana (Smith) BOYER in Okamura, Littoral Diatoms Japan (1911) 9, pl. 12, fig. 42.

A cosmopolitan diatom, forming a straight chain composed of robust triangular frustules. The length and the breadth of the cells vary from 0.045 to 0.105 millimeter. Geographic distribution: Common in the littoral zone and sometimes in plankton. Atlantic and Pacific Oceans; environs of Vladivostok and Dairen. Localities 1 and 2.

BIDDULPHIA LONGICORNIS Greville. Plate 2, fig. 16.

A. SCHMIDT, Atlas Diatom. pl. 118, fig. 10; OKAMURA, Littoral Diatoms Japan (1911) 11, pl. 12, fig. 46.

Valve seen in face view broadly elliptical, with pointed ends forming an obtuse angle, in which, close to the apices, arise two long horns. Valve ornamented with rows of beads running longitudinally along the valve. In side or girdle view each valve shows two very long outwardly curving horns and two long spines in the middle part of the ends. Girdle broad and curved with closely set rows of transverse beading. Length of the valve 0.066 to 0.075 millimeter, breadth 0.074 to 0.085 millimeter. Geographic distribution: Pacific Ocean. Locality 4.

THALASSIOTHRIX ANTARCTICA Schimper forma **JAPONICA** forma nov. Plate 9, figs. 1 and 2.

Valve straight, linear, apices slightly produced. Length, 1.6 to 1.95 millimeters; breadth, 0.0055 to 0.0075. Striæ fifteen in 0.01 millimeter. Our form differs from the typical *T. antarctica* by its straight valve. Geographic distribution: Atlantic and Pacific Oceans. Locality 4.

THALASSIOTHRIX NITZSCHIOIDES Grunow. Plate 8, figs. 10 and 11.

V. HEURCK, Synopsis (1880–85) pl. 43, fig. 7.

Synedra nitzschioides GRUNOW, Österreich. Diatom. (1862) 403, pl. 5, fig. 18.

Thalassiothrix curvata CASTRACANE, Diatom. Challenger Exped. (1886) 55, pl. 24, fig. 6.

Thalassiothrix frauenfeldi CLEVE, Plankton., Ciliof., och Diatom. (1894) 6.

Thalassiothrix frauenfeldi var. *nitzschioides* in JÖRGENSEN, Protophyten und Protozoen Plankt. (1900) 20; PERAGALLO, Diatom. Mar. France (1897–1908) 320, pl. 131, figs. 17, 18.

Cells forming star-shaped or zigzag clusters. Cells linear, 0.037 to 0.06 millimeter in length, 0.0025 to 0.006 in breadth; striæ 11 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans; known from Japan, Eastern and South China Seas. Localities 2, 4, and 5.

THALASSIOTHRIX NITZSCHIOIDES var. JAVANICA Grunow. Plate 9, fig. 6.

V. HEURCK, Synopsis (1880–85) pl. 98, figs. 11, 12.

Cells lanceolate, with slightly elongated, rounded apices. Length, 0.042 to 0.055 millimeter; breadth, 0.0042 to 0.055; striæ marginal, 9 to 10 in 0.01 millimeter. Geographic distribution: Java Sea. Locality 4.

THALASSIOTHRIX FRAUENFELDII Grunow. Plate 9, fig. 8.

CLEVE and GRUNOW, Arkt. Diatom. (1880) 109.

Asterionella frauenfeldii GRUNOW, Verhandl. Zool.-Bot. Gesellsch. (1863) 140, pl. 14.

Asterionella frauenfeldii GRUNOW, Novara Algen (1867) 4.

Asterionella synedraeformis GREVILLE, Ann. Nat. Hist. (1865) 4, pl. 5, figs. 5, 6.

Thalassiothrix frauenfeldii (Grunow) CASTRACANE, Diatom. Challenger Exped. (1886) 54–55, pl. 14, figs. 7, 8; PERAGALLO, Diatom. Mar. France (1897–1908) 321, pl. 131, fig. 15.

Cell linear, 0.22 to 0.29 millimeter in length, 0.004 to 0.005 in breadth, forming large star-shaped clusters. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Eastern and South China Seas. Localities 4 and 5.

ASTERIONELLA JAPONICA Cleve. Plate 9, fig. 9.

GRAN, Nord. Plankton (1906) 118, fig. 160.

Asterionella glacialis CASTRACANE, Diatom. Challenger Exped. (1886) 50, pl. 14, fig. 1; SCHRÖDER, Phytopl. Warm. Meere (1906) 330–37; OKAMURA, Littoral Diatoms Japan (1911) 11, pl. 13, fig. 56.

Length of valve, 0.11 to 0.205 millimeter; breadth on one end, 0.003, on the other end, 0.018. Geographic distribution: Antarctic, Atlantic, and Pacific Oceans; in Japanese waters known from Shira-hama, Misaki, and Shima. Localities 2, 4, and 5.

GRAMMATOPHORA JAPONICA Grunow. Plate 10, fig. 13.

GRUNOW in V. Heurck, Synopsis (1880–85) pl. 103, fig. 18; PERAGALLO, Diatom. Mar. France (1897–1908) 358, pl. 137, fig. 26.

Valve 0.052 to 0.06 millimeter in length, 0.028 to 0.03 in breadth; striæ 28 in 0.01 millimeter. Geographic distribution: Pacific Ocean, Sea of Japan, Dairen. Localities 1 and 2.

GRAMMATOPHORA MARINA (Lyngby) Kützing. Plate 2, fig. 15.

KÜTZING, Bacillar. (1844) 128, pl. 17, fig. 24; W. SMITH, Brit. Diatom. (1853–56) 11, 42, pl. 42, fig. 314; SCHÜTT, Bacillar. (1896) 106, figs. 187, A–B; PERAGALLO, Diatom. Mar. France (1897–1908) 353, pl. 137, figs. 6–8.

Cell 0.021 to 0.027 millimeter in length, 0.017 to 0.02 in breadth; striæ 22 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Mediterranean Sea, Sea of Japan, Vladivostok, and Dairen.

SYNEDRA AURICULATA Karsten. Plate 10, fig. 2.

KARSTEN, Phytopl. Atlant. Ocean (1906) 173, pl. 30, figs. 18*a*, *b*.

Valve linear, straight, 0.8 to 1.2 millimeters in length, 0.006 in breadth. The ends inflated and shortly rounded, striæ 15 in 0.01 millimeter. Geographic distribution: Atlantic Ocean. Locality 4.

SYNEDRA KOREANA sp. nov. Plate 9, figs. 3, 4, and 5.

Valve straight, lanceolate or linear, inflated in the middle part forming a broad lanceolate pseudoraphe. Ends inflated, prolonged into rostrate apices. Length, 2.22 to 2.56 millimeters; breadth in the middle, 0.011 to 0.013; striæ, 10 in 0.01 millimeter. Localities 4 and 5.

NAVICULA PELLUCIDA Karsten. Plate 9, figs. 11 and 12.

KARSTEN, Phytopl. Antarkt. Meere (1905) 126, pl. 18, fig. 3.

Valve elliptic with elongated rounded ends. Length, 0.088 to 0.115 millimeter; breadth, 0.029 to 0.04; median line with the terminal fissures indistinct. Axial area also indistinct; central small. Striæ 20 to 28 in 0.01 millimeter, obscure, thin. This diatom should not be confused with the later-named *N. pellucida* Cleve. Localities 2, 4, and 5.

NAVICULA (CISTULA) LORENZIANA Grunow. Plate 8, fig. 16.

GRUNOW, Oster. Diatom. (1860) 547, pl. 3, fig. 3; CLEVE, Synopsis Nav. Diatom. (1894) 124; PERAGALLO, Diatom. Mar. France (1897–1908) pl. 7, fig. 6; A. SCHMIDT, Atlas Diatom., pl. 212, figs. 51–56.

Valve broad, rectangular. Striæ composed of elongated puncta 15 to 18 in 0.01 millimeter. Rows of puncta 7 in 0.01 millimeter. Length of valve, 0.04 to 0.05 millimeter; breadth, 0.019 to 0.02. Geographic distribution: Littoral zone of England, Balearic Islands, Adriatic, Campeche Bay, Port Jackson, Yokohama. Locality 4.

NAVICULA (SCHIZONEMA) RAMOSISSIMA Agardh forma AMPLIA Grunow. Plate 10, fig. 3.

Schizonema amplius V. HEURCK, Synopsis (1880–85) pl. 15, fig. 3; PERAGALLO, Diatom. Mar. France (1897–1908) pl. 12, fig. 9.

Valve linear-lanceolate with obtuse ends. Length, 0.064 to 0.07 millimeter; breadth, 0.012 to 0.017; striæ, 12 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, a benthonic species. Localities 1 and 2.

NAVICULA (SCHIZONEMA) MOLLIS W. Smith. Plate 8, fig. 15.

W. SMITH, Brit. Diatom. (1853–56) 11, 77, pl. 58, fig. 365; V. HEURCK, Synopsis (1880–85) pl. 15, figs. 22, 23.
Schizonema albicans V. HEURCK, Synopsis, pl. 15, fig. 20.
Schizonema torquatum V. HEURCK, Synopsis, pl. 15, fig. 21.

Valve lanceolate, obtuse; length, 0.028 to 0.03 millimeter; breadth, 0.008 to 0.009; striæ, 18 in 0.01. Geographic distribution: Arctic America, Cape Sabine, Bahuslan, North Sea, Adriatic. Localities 1 and 2.

NAVICULA KARIANA Grunow var. MINOR Grunow forma JAPONICA forma nov. Plate 8, fig. 12.

Valve broadly lanceolate with rostrate ends. Length, 0.023 to 0.027 millimeter; breadth, 0.009; striæ, 18 to 20 in 0.01 millimeter. The typical *Navicula kariana* Grunow [1] and var. *minor* Grunow [2] and var. *minor* Grunow forma *curta* Cleve [3] are known from Franz Josef Land, Sea of Kara, Cape Wankarema, Davis Strait, and Cape Deschnew. Locality 1 .

PLEUROSIGMA LONGUM Cleve var. INFLATA Peragallo forma JAPONICA forma nov. Plate 10, fig. 15.

Valve lanceolate, sigmoid, acute. Length, 0.136 to 0.15 millimeter; breadth, 0.017 to 0.02; striæ, 17 in 0.01 millimeter. Geographic distribution: The typical var. *inflata* is known from the Mediterranean. Locality 4.

PLEUROSIGMA WANSBECKII Donkin. Plate 10, fig. 14.

Pleurosigma balticum var. *wansbeckii* DONKIN in Peragallo, Diatom. Mar. France (1890–91) 19, pl. 7, figs. 23, 24.

Valve linear. Length, 0.119 to 0.2 millimeter; breadth, 0.015 to 0.02. Geographic distribution: Sea of Kara and North Sea. Locality 4.

[1] Arct. Diatom., 39, pl. 2, fig. 44.
[2] Arct. Diatom., 5; = *N. frigida* Grunow in Arct. Diatom., 39.
[3] Diatom. Exped. Vega (1883) 469, pl. 37, fig. 40.

GUINARDIA FLACCIDA (Castracane) Peragallo. Plate 2, fig. 17.

PERAGALLO, Diatomiste 1 (1892) 107, pl. 13, figs. 3, 4.

Rhizosolenia flaccida CASTRACANE, Diatom. Challenger Exped. (1886) 74, pl. 29, fig. 4.

Henseniella baltica SCHÜTT in De Toni, Sylloge Algarum (1894) 1425.

Guinardia baltica SCHÜTT, Bacillar. (1896) 84, fig. 138; OKAMURA, Littoral Diatoms Japan (1911) 4, pl. 9, fig. 15; HUSTEDT, Kieselalgen (1929) 561–64, fig. 322.

Cell cylindrical, from 0.023 to 0.07 millimeter broad and two to three times as long as broad, forming a long straight chain. Chromatophores numerous, cross-shaped. Geographic distribution: Atlantic and Pacific Oceans, Mediterranean Sea, and Sea of Japan. Localities 2, 4, and 5.

RHIZOSOLENIA ALATA Brightwell. Plate 10, figs. 9 and 10.

BRIGHTWELL, Quar. Journ. Micr. Sc. 6 (1858) 96, pl. 5, fig. 8; PERAGALLO, Monogr. Rhizosol. (1892) 20, pl. 5, fig. 11; Diatom. Mar. France (1897–1908) pl. 18, fig. 11; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 317, figs. 1–7; HUSTEDT, Kieselalgen (1929) 600; OKAMURA, Littoral Diatoms Japan (1911) 6, pl. 9, fig. 27.

Cell 0.17 to 0.4 millimeter in length and 0.011 to 0.013 in breadth. Geographic distribution: Atlantic and Pacific Oceans; common in Japanese waters and known from Cape Goza, Shirahama, Province of Tosa, and Mikawa. Localities 2 and 4.

RHIZOSOLENIA ALATA Brightwell forma **GRACILLIMA** (Cleve) Grunow. Plate 10, figs. 11 and 12.

V. HEURCK, Synopsis (1880–85) pl. 79, fig. 8.

Rhizosolenia (*alata* var.) *gracillima* CLEVE, Kongl. Sv. Vet.-Akad. Handl. **18** (1881) 26, pl. 6, fig. 78; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 317, figs. 8–10; HUSTEDT, Kieselalgen (1929) 601, fig. 345.

Cells about 0.006 to 0.0074 millimeter in breadth and 0.2 to 0.85 in length. Geographic distribution: Atlantic, Pacific, and Indian Oceans, Mediterranean and Red Seas, Malay Archipelago, New Zealand, Sea of Japan. Localities 2, 4, and 5.

RHIZOSOLENIA SETIGERA Brightwell. Plate 10, fig. 5.

BRIGHTWELL, Quar. Journ. Micr. Sc. **6** (1858) pl. 5, fig. 4; V. HEURCK, Synopsis (1880–85) pl. 78, figs. 7, 8.

Rhizosolenia japonica CASTRACANE, Diatom. Challenger Exped. (1886) 23, fig. 7; PERAGALLO, Monogr. Rhizosol. (1892) 17, pl. 4, figs. 12–16; Diatom. Mar. France (1897–1908) 464, pl. 124, figs. 11–15; OKAMURA, Littoral Diatoms Japan (1911) 5, pl. 9, fig. 22; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 320, figs. 6–8.

Valve linear, slightly siliceous, 0.75 to 0.9 millimeter in length, 0.01 to 0.014 in breadth with structure hardly visible. Spine long, thin; 0.12 to 0.14 millimeter in length. Geographic

distribution: Atlantic, Pacific, and Indian Oceans, Mediterranean and Red Seas, Malay Archipelago, Sea of Japan. Localities 2, 4, and 5.

RHIZOSOLENIA ROBUSTA Norman. Plate 10, fig. 4.

PRITCHARD, Histor. Infusor. (1861) 866, pl. 8, fig. 42.
Rhizosolenia sigma SCHÜTT, Pflanzenleb. d. Hochsee (1893) 22, fig. 2; PERAGALLO, Monogr. Rhizosol. (1892) 14, pl. 2, fig. 1; pl. 3, figs. 1, 2; Diatom. Mar. France (1897–1908) pl. 123, figs. 1, 2; KARSTEN, Indische Phytopl. (1907) 163, pl. 29, fig. 10; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 320, figs. 1–3; Kieselalgen (1929) 578–80, fig. 330; OKAMURA, Littoral Diatoms Japan (1911) 4, pl. 9, fig. 18.

Cell robust, 0.13 to 0.22 millimeter in breadth, 0.5 to 0.7 in length. The end is curved, contracted, pointed. Geographic distribution: Indian and Pacific Oceans, Mediterranean and Red Seas, Malay Archipelago, Sea of Japan. Localities 2, 4, and 5.

RHIZOSOLENIA HYALINA Ostenfeld. Plate 10, figs. 6, 7, and 8.

OSTENFELD and SCHMIDT, Plankt. Rode Hav Og Adenbugten (1901) 160–61, fig. 11; HUSTEDT in A. Schmidt, Atlas Diatom. (1920) pl. 319, figs. 11–13.

According to Cleve the original diagnosis of this diatom is as follows:

Frustule very slightly siliceous (length 0.28 to 0.34 millimeter, width 0.028 to 0.032); structure hardly visible, squamate (4–5 squamae at the same height); spine (0.032 to 0.04 millimeter long) very thin, slowly incrassated at the base; valve in a front view with a characteristic undulation, of the contour and with a fissure, in which the spine of the neighbour cell is fastened.

Geographic distribution: Red Sea, Japan (Binn-meer bei Akashi, r.m. by Hustedt). Locality 4.

NITZCHIELLA LONGISSIMA (Brébisson) Ralfs forma **TYPICA** V. Heurck. Plate 10, fig. 1.

Nitzschia birostrata SMITH, Brit. Diatom. 1 (1853–56) 42, pl. 14, fig. 117; V. HEURCK, Synopsis (1880–85) pl. 70, figs. 1–2; Traite Diatom. (1899) 404, pl. 17, figs. 568.

Valve with long horns, 0.5 to 0.7 millimeter in length. Geographic distribution: A cosmopolitan diatom known in many places. Localities 1 and 2.

NITZCHIELLA LONGISSIMA (Brébisson) Ralfs forma **PARVA** V. Heurck. Plate 9, fig. 7.

V. HEURCK, Synopsis (1880–85) pl. 70, fig. 3; Traite Diatom. (1899) 404, pl. 17, fig. 568; PERAGALLO, Diatom. Mar. France (1897–1908) 293, pl. 124, figs. 16–18.

A delicate diatom, 0.29 to 0.3 millimeter in length and 0.009 in breadth. Geographic distribution: Atlantic and Pacific

Oceans, in littoral zone in benthos and plankton. Localities 1, 2, and 5.

SURIRELLA GEMMA Ehrenberg var. **OVATA** var. nov. Plate 8, fig. 13.

Valve broad ovate. Length, 0.068 to 0.072 millimeter; breadth, 0.037 to 0.04. Costæ 3 in 0.01 millimeter. Typical *Surirella gemma*[4] have more-elongated valves. Geographic distribution: Atlantic and Pacific Oceans in littoral zone and in plankton. Localities 1 and 2.

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[4] Figured in A. Schmidt, Atlas Diatom. pl. 24, figs. 26–27, and in V. Heurck, Synopsis pl. 74, pls. 1–3.

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ILLUSTRATIONS

PLATE 1

FIGS. 1 and 2. *Coscinodiscus concinnus* W. Smith.
FIG. 3. *Coscinodiscus radiatus* Ehrenb.
4. *Coscinodiscus concinnus* W. Smith, an abnormal valve.
FIGS. 5 and 6. *Coscinodiscus concinnus* W. Smith. The middle parts of the valves greatly enlarged.

PLATE 2

FIGS. 1 and 2. *Stephanopyxis palmeriana* (Grev.) Grun.
FIG. 3. *Stephanopyxis palmeriana* forma *curta* forma nov.
4. *Stephanopyxis turris* (Grev. and Arn.) Ralfs.
FIGS. 5 and 6. *Eucampia zodiacus* Ehrenb.
7 and 8. *Ditylium brightwellii* (West) Grun.
FIG. 9. *Eucampia biconcava* (Cleve) Ostenf.
10. *Thalassiosira hyalina* (Grun.) Gran.
11. *Lauderia borealis* Gran.
12. *Biddulphia pulchella* Gray.
13. *Schroederella delicatula* (Per.) Pavil.
14. *Leptocylindrus curvatus* sp. nov.
15. *Grammatophora marina* (Lyngb.) Kütz.
16. *Biddulphia longicornis* Grev.
17. *Guinardia flaccida* (Castr.) Per.

PLATE 3

FIG. 1. *Chaetoceras boreale* Bail.
2. *Chaetoceras javanicum* Cleve.
3. *Chaetoceras siamense* Ostenf.
4. *Chaetoceras lorenzianum* Grun.

PLATE 4

FIG. 1. *Chaetoceras messanense* Castr.
2. *Chaetoceras affine* Lauder.
3. *Chaetoceras saltans* Cleve.
FIGS. 4 and 5. *Chaetoceras peruvianum* Brightw.

PLATE 5

FIG. 1. *Chaetoceras compressum* Lauder.
2. *Chaetoceras radians* Schütt.
3. *Chaetoceras didymum* Ehrenb. var. *genuina* Gran.
4. *Chaetoceras protuberans* Lauder.
5. *Chaetoceras didymum* Ehrenb. var. *genuina* Gran.
6. *Chaetoceras didymum* Ehrenb. var. *anglica* Gran.
7. *Chaetoceras sociale* Lauder.

PLATE 6

FIG. 1. *Chaetoceras dadayi* Pavil.
2. *Chaetoceras tortissimum* Gran.
FIGS. 3 and 4. *Chaetoceras decipiens* Cleve.

PLATE 7

FIG. 1. *Chaetoceras ikari* sp. nov.
2. *Chaetoceras reichelti* Hustedt.
FIGS. 3, 4, and 5. *Chaetoceras atlanticum* Cleve.

PLATE 8

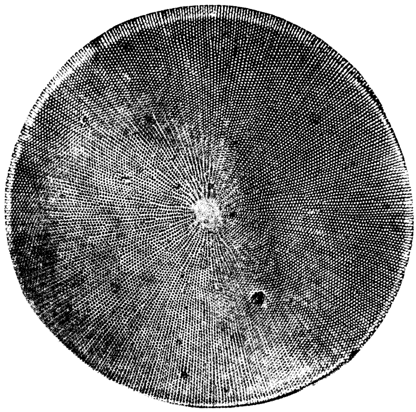
FIG. 1. *Bacteriastrum varians* Lauder.
2. *Bacteriastrum hyalinum* Lauder.
3. *Bacteriastrum varians* Lauder.
4. *Bacteriastrum minus* Karsten.
FIGS. 5, 6, and 7. *Bacteriastrum varians* Lauder.
FIG. 8. *Bacteriastrum comosum* Pavil. var. *hispida* (Castr.) Ikari.
9. *Biddulphia sinensis* Grev.
FIGS. 10 and 11. *Thalassiothrix nitzschioides* Grun.
FIG. 12. *Navicula kariana* Grun. var. *minor* Grun. forma *japonica* forma nov.
13. *Surirella gemma* Ehrenb. var. *ovata* var. nov.
14. *Corethron pelagicum* Brun.
15. *Navicula* (*Schizonema*) *mollis* W. Smith.
16. *Navicula* (*Cistula*) *lorenziana* Grun.

PLATE 9

FIGS. 1 and 2. *Thalassiothrix antarctica* Schimper forma *japonica* forma nov.
3, 4, and 5. *Synedra koreana* sp. nov.
FIG. 6. *Thalassiothrix nitzschioides* var. *javanica* Grun.
7. *Nitzchiella longissima* (Breb.) Ralfs forma *parva* V. Heurck.
8. *Thalassiothrix frauenfeldii* Grun.
9. *Asterionella japonica* Cleve.
10. *Planktoniella sol* (Wallich) Schütt.
FIGS. 11 and 12. *Navicula pellucida* Karsten.

PLATE 10

FIG. 1. *Nitzchiella longissima* (Breb.) Ralfs forma *typica* V. Heurck.
2. *Synedra auriculata* Karsten.
3. *Navicula* (*Schizonema*) *ramosissima* Ag. forma *amplia* Grun.
4. *Rhizosolenia robusta* Norman.
5. *Rhizosolenia setigera* Brightw.
FIGS. 6, 7, and 8. *Rhizosolenia hyalina* Ostenf.
9 and 10. *Rhizosolenia alata* Brightw.
11 and 12. *Rhizosolenia alata* forma *gracillima* (Cleve) Grun.
FIG. 13. *Grammatophora japonica* Grun.
14. *Pleurosigma wansbeckii* Donk.
15. *Pleurosigma longum* Cleve var. *inflata* Perag. forma *japonica* forma nov.



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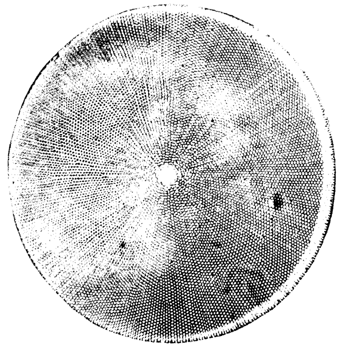

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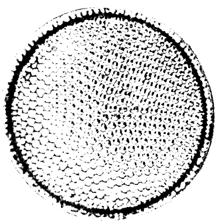

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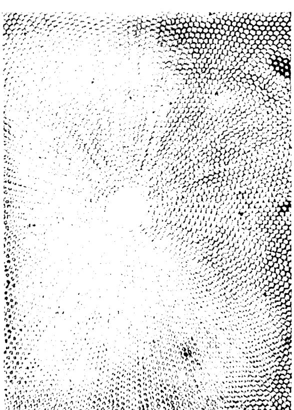

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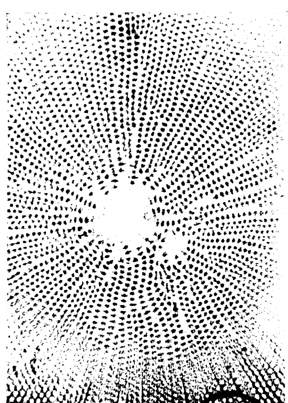

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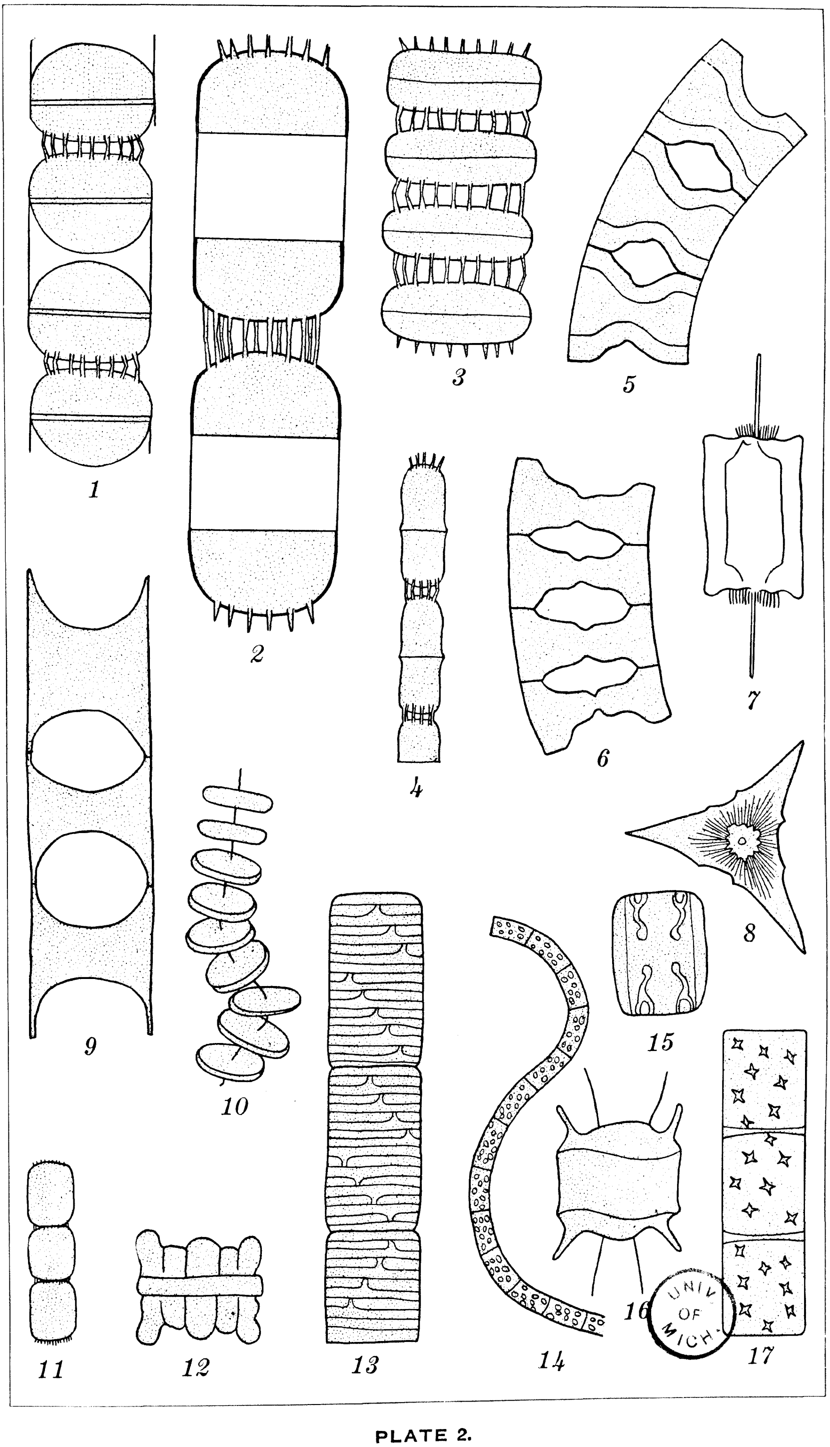
PLATE 1.



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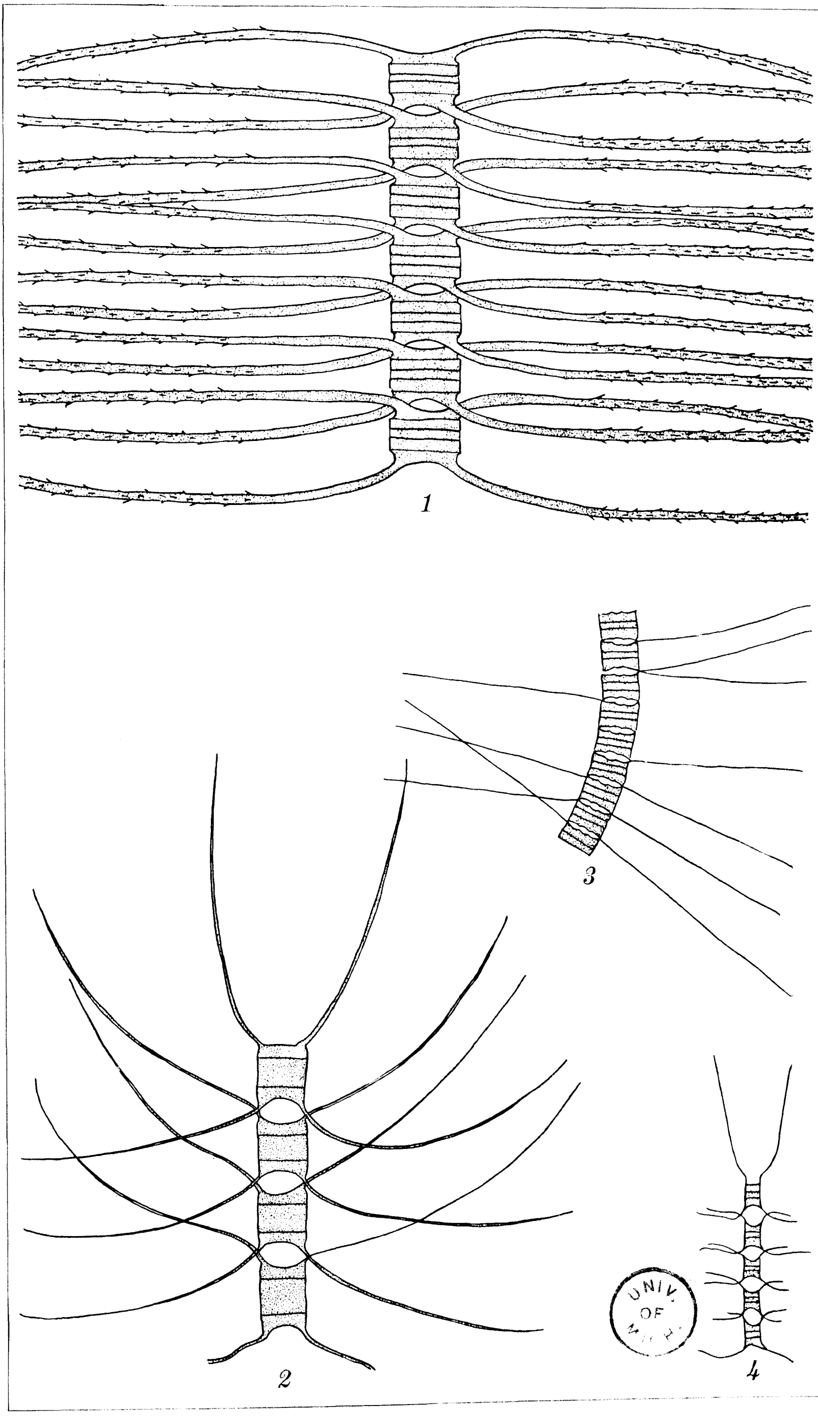

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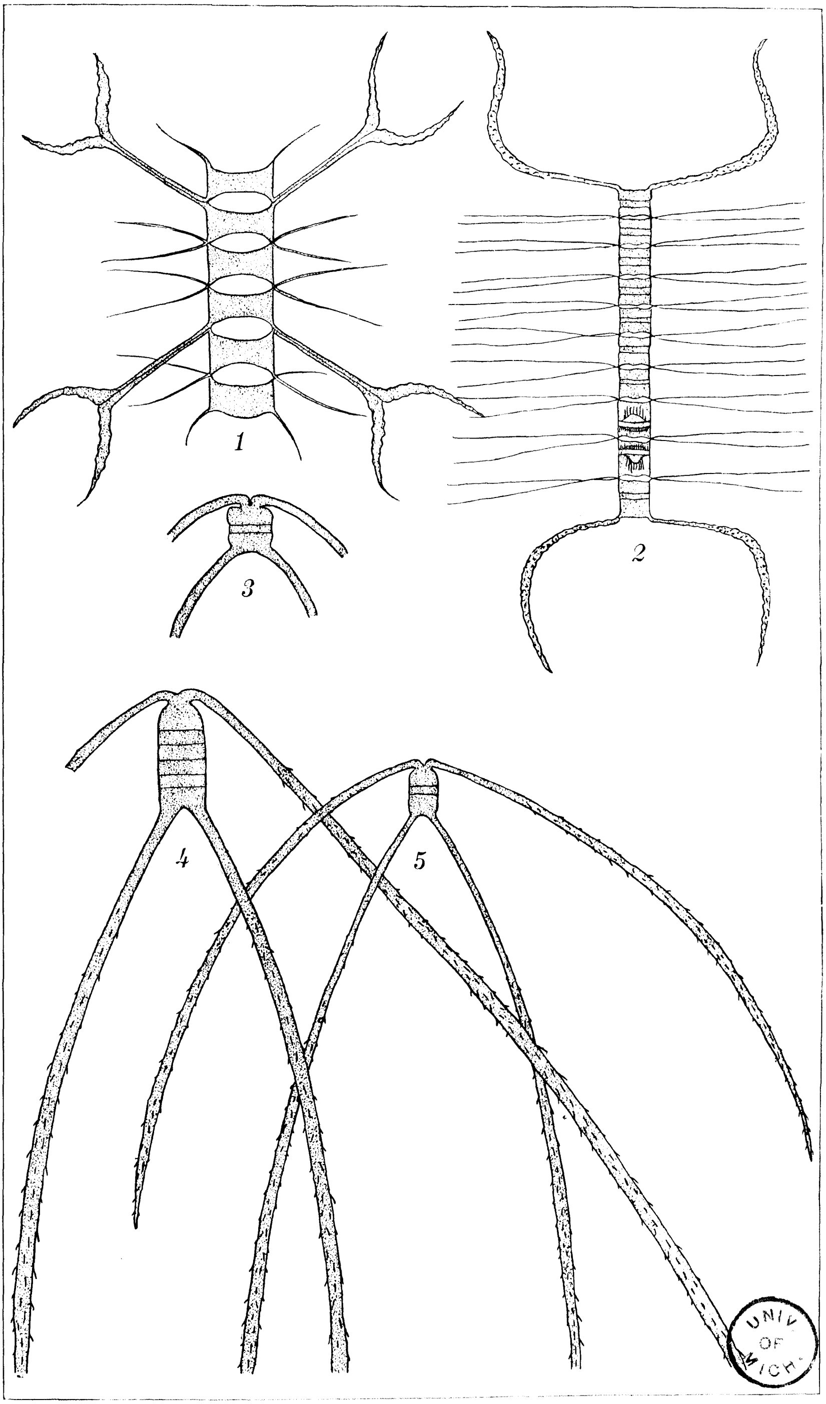

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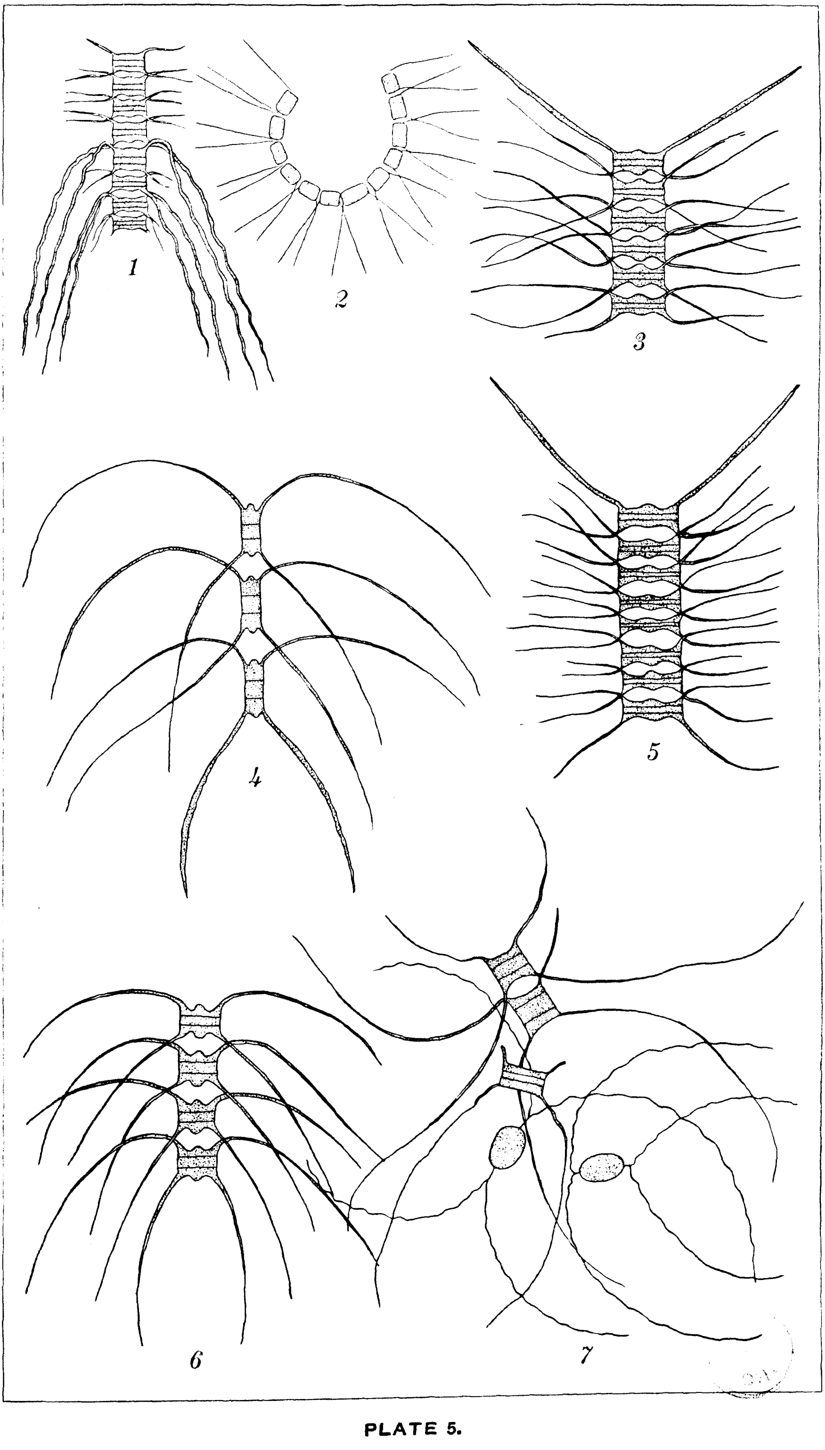

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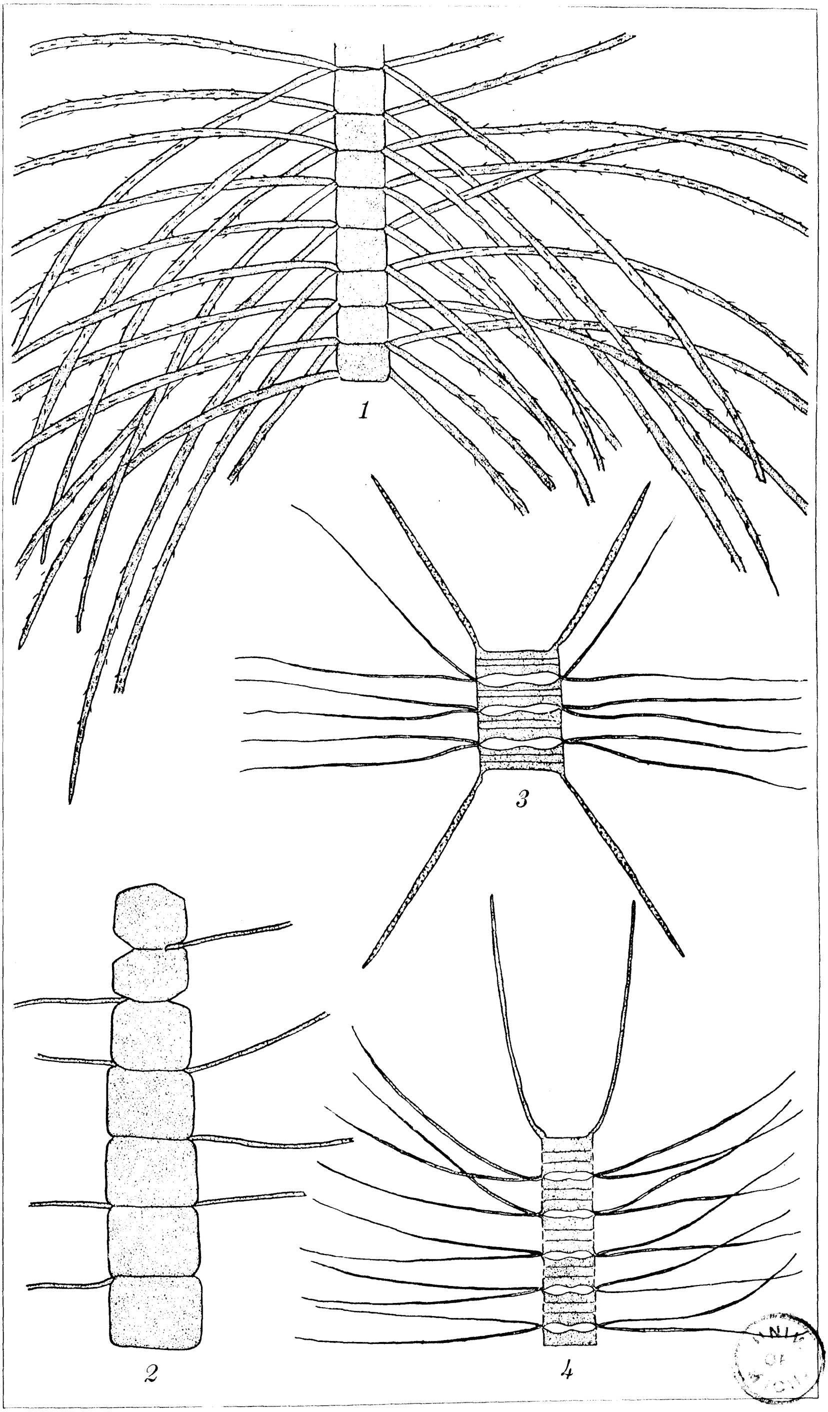

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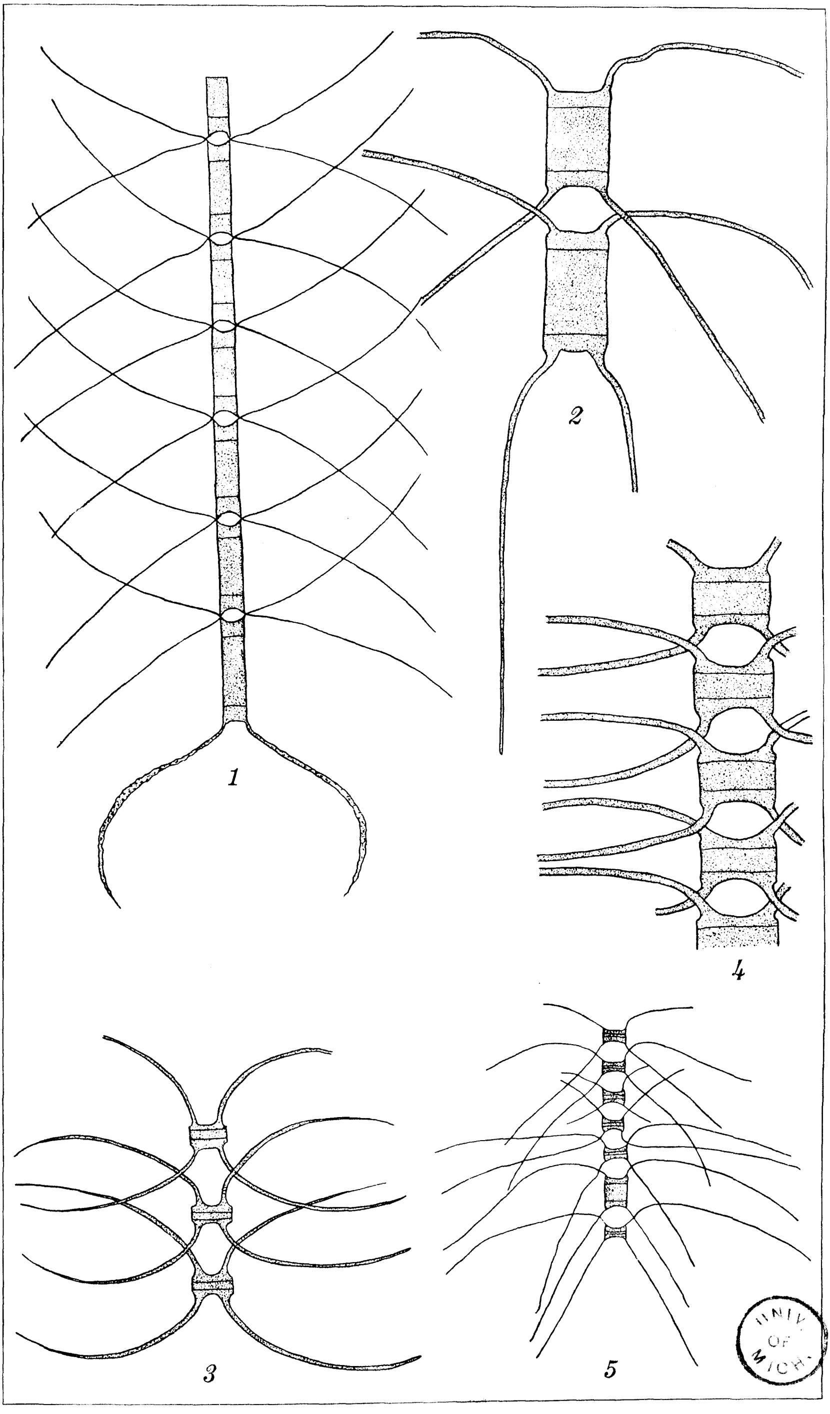

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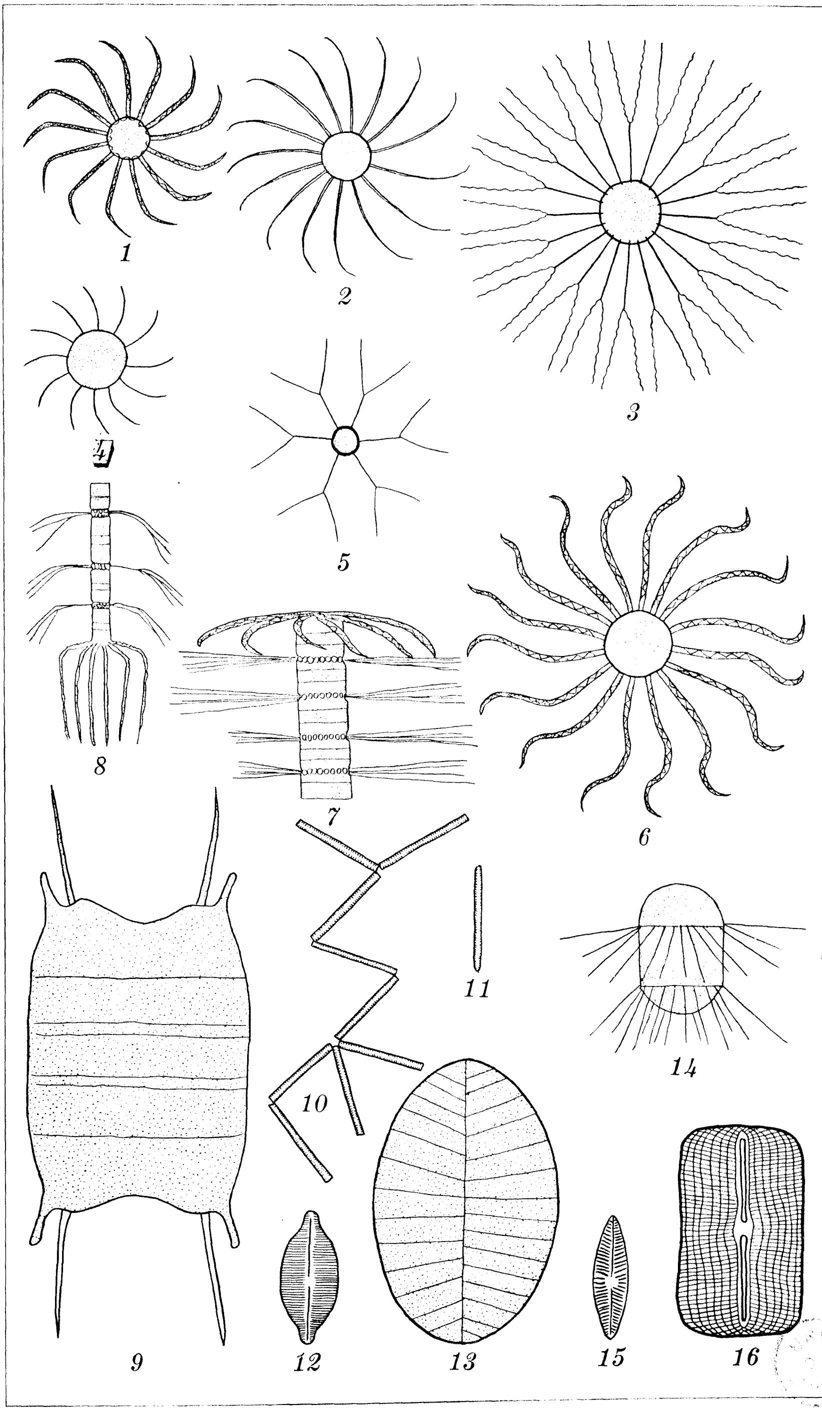

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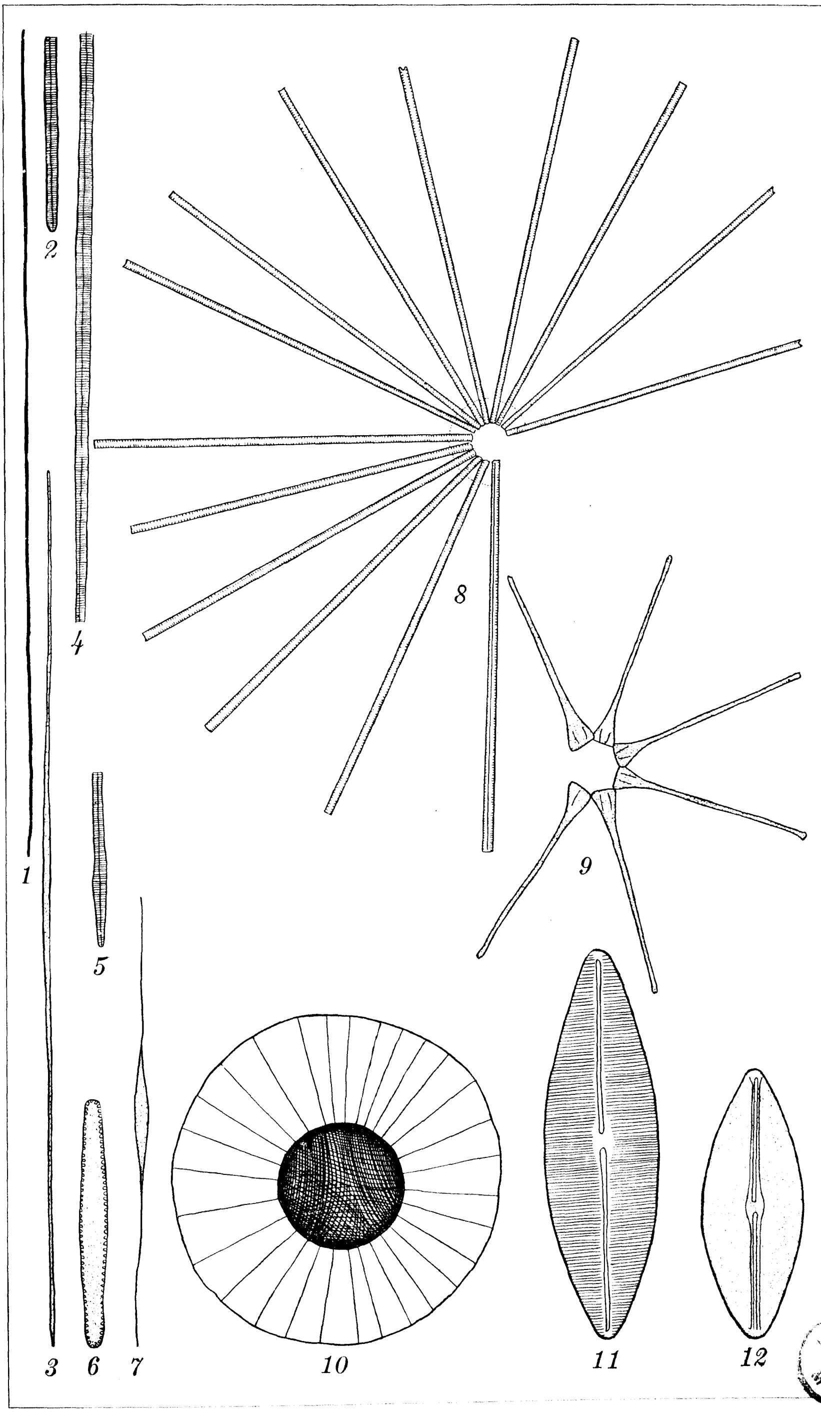


PLATE 9.

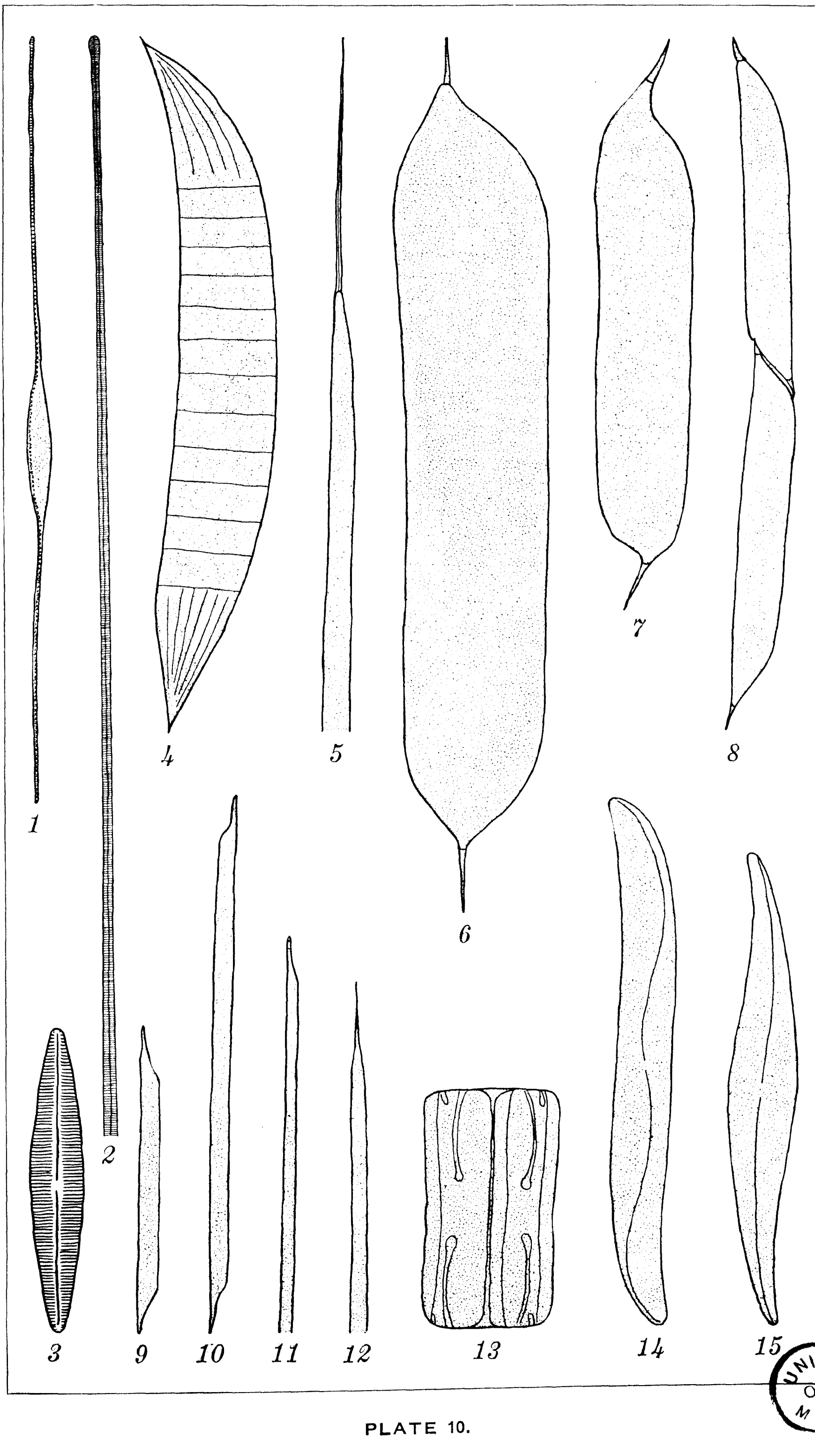


PLATE 10.

THE HISTAMINE TEST AS AN AID IN THE DIAGNOSIS OF EARLY LEPROSY

By JOSE RODRIGUEZ and FIDEL C. PLANTILLA

Of the Philippine Health Service, Cebu, Cebu

It is generally agreed that one of the greatest needs in leprosy work to-day is a reliable serological test that can be depended upon to detect the disease in its earliest stages. Unfortunately, in spite of claims of some to the contrary, such a test does not yet exist. Until one has been elaborated and since in the "incipient stage" the presence of *Mycobacterium leprae* cannot usually be demonstrated on ordinary methods of making the bacteriological examination, we have to depend almost entirely on clinical methods such as the detection of the anæsthesia, palpation of thickened nerves and superficial glands, careful history-taking, and examination of the external lesions as to appearance, location, etc., in order to arrive at a diagnosis in this stage. Naturally the accuracy of the diagnosis must depend to a great extent on the experience of the physician making the diagnosis. The introduction, therefore, of any clinical test that will tend to minimize the influence of the personal equation should prove of value.

We believe that we have found such a test in the so-called "histamine test." When a dilute solution of histamine is pricked into the normal skin, a reaction takes place in about twenty seconds, starting with the appearance of a circular, sharply defined, local reddening surrounding the prick, and measuring when fully developed from 3 to 4 millimeters in diameter. This is followed in another fifteen to thirty seconds by a flush or "flare" that appears on the surrounding skin. It is of the utmost importance to distinguish this flare from the local red reaction. The flare is dark red or scarlet contrasting with the brighter shade of the latter; it has diffused and often crenated borders that may extend from 2 to 3 centimeters from the center of the reaction. Soon after the appearance of the flare, a discreet wheal forms at the site of the prick; this is generally at its maximum development in from three to five minutes, at

which time it measures from 3 to 4 millimeters in diameter and about 1 to 2 millimeters in height. The wheal usually occupies the area originally covered by the local red reaction, although in many cases the two do not coincide, the wheal being usually smaller than the localized red area.

The full reaction of the normal skin to histamine, consisting of the local redness or vasodilation, the flare, and the œdema or wheal has been called by Lewis [1] the "triple response."

Lewis has demonstrated that the triple response is a characteristic reaction of the normal skin following injury inflicted by such agents as heavy stroking, pricking, scratching, freezing, heating, electrical shocks, as well as by the introduction of irritant substances such as acids, alkalies, mustard oil, cantharidis, nettle sting, morphine, etc. Ultraviolet rays, ordinary sunlight, X-ray and radium emanations, bacterial poisons, certain chemicals such as dichloraethylsulphide, etc., give rise to more slowly developing reactions. He has also proven that the local redness and the wheal or œdema are due to direct action of the injury or irritant on the capillaries, while the flare is produced by the dilatation of the arched arterioles and is reflex in nature, being dependent upon the integrity of the cutaneous nerves. The arteriolar dilatation is mediated through a purely local nervous reflex and does not depend upon a spinal reflex arc.

This test has been tried by Lewis and his colleagues [2] on anæsthetic skin to which the sensory nerves have been cut surgically or interrupted by injection of anæsthetics. When the interruption produced surgically or by anæsthesia is recent, the reaction to the histamine test is complete in all its details, although the skin has already been rendered anæsthetic; but if sufficient time (six to fifteen days) is allowed for the nerve to degenerate after surgical section or if the skin is anæsthetized locally, the flare is lost. Under these circumstances, the local red reaction and the œdema appear as in the normal reaction of the skin.

Thus, the loss of the flare following a histamine test is a sign of degeneration of the sensory nerves supplying the skin tested, and possibly also of direct involvement of the nerve endings as in local anæsthesia.

[1] The Blood Vessels of the Human Skin and their Responses. Shaw & Sons, Ltd., London (1927) 47.

[2] Op. cit. 69–70.

Histamine, or β-iminazolylethylamine, is described by Lewis as "the amine produced when carbon dioxide is split from histidine, a substance occurring naturally in the body and a protein derivative." It was extracted by Barger and Dale[3] from the intestinal mucosa, and was later thoroughly studied by Dale and Laidlaw.[4] The histamine test as applied on the skin was first reported by Eppinger[5] and later elaborated by Sollman and Pilcher[6] and by Lewis and Grant.[7]

THE TEST

In most of our tests, we have used a 1 to 1,000 dilution of the phosphate in normal salt solution. With stronger solutions a larger flare is occasionally obtained, but the reactions are not as constant as with the 1 to 1,000 solution.

A small drop of the solution is carefully placed within the suspicious macule to be tested and another is dropped on normal skin at least 2.5 centimeters from the border of the lesion for control. With a sharp pin, a prick is made through the drop into the skin underneath, taking care to exert just sufficient pressure to drive the point through the epidermis without causing any bleeding. The histamine solution is wiped off immediately, and the pricks are closely observed under good natural light.

The test is said to be negative when the complete response is elicited and positive when the flare is absent.

There are some individuals on whom the normal reaction is diminished; in a few, the flare is so faint as to be practically absent. When the response is weak and the skin tested is on an extremity, the flare may be brought out to its maximum extent and intensity by previously congesting the extremity with the help of a broad rubber band or the pneumatic cuff of a blood-pressure apparatus.

Finally, it must be recognized that the reaction is harder to elicit on the dark skin of a Filipino than on white skin.

[3] Journ. of Physiol. 41 (1910–11) 499–503.

[4] Journ. of Physiol. 41 (1910–11) 318–344; 43 (1911–1912) 182–195.

[5] Wein. med. Wochenschr. 43 (1913) 1414.

[6] Journ. of Pharmacol. and Eper. Therap. 9 (1917) 309–340.

[7] Vascular Reactions of the Skin to Injury. Part II, Heart 11 (1924) 209–265.

RESULT OF THE HISTAMINE TEST IN LEPROSY

In the pale macule.—The flush is always absent in the depigmented macule of leprosy. When the histamine prick is made just outside the border, a flare develops on the normal skin but stops sharply at the border and does not extend into the macule. When the prick is made just inside the border, the flare is prevented from appearing even on the bordering normal skin.

A word of caution must be given at this point. The flare generally masks the local redness following the histamine test on the normal skin. When the flare is abolished as in a leprotic macule, the local redness becomes prominent and may be mistaken for the flare by the beginner. The area of local redness is sharply localized, circular in shape, bright red or pink in color, extending at the most 2 or 3 millimeters beyond the wheal, and tends to become cyanotic before fading. On the other hand, the flare is not definitely localized, the size is usually about 3 to 4 centimeters in diameter, irregular in shape, although it tends to be oblong with its long axis along the length of the member, and the color is dark red. On fading the flare becomes speckled, but the color remains the same from beginning to end.

The wheal in the macule is usually of the same size as that on the normal skin. Sometimes the œdema may be less; at other times the wheal develops faster in the macule, reaching its full development in two minutes, while the wheal on the control skin is at its height in three to five minutes. The ultimate size, however, is almost the same.

The test has been applied on the macules of *Tinea flava* and other types of pale-looking pityriases, on leucoderma, old scars, fading psoriasis lesions, etc., which may be mistaken for the pale macule of leprosy. In every case, the flare is present provided the individual is not unsusceptible to histamine, in which case, the flare is also diminished or absent on the normal skin.

In the reddish macule.—When the redness of the lesion is marked, only the wheal may be elicited; but when the color is not so striking, the local redness may be seen.

When hyperæsthesia is present, as is usually the case when the lesion is bacteriologically positive, the flare is not constant. In a few macules the flare is present; in the majority of the cases it is absent. If there is accompanying infiltration or œdema so marked that the skin looks tense, glistening, and bright red in color, the wheal is apt to be slight or absent.

The histamine test was tried in cases of dermatitis from various causes, active psoriasis lesions, tinea circinata and other ringworm infections, fresh scars, and other lesions that may simulate the red macule. When the inflammation in such lesions is active and there is considerable redness, the wheal is generally diminished or even absent while the flare is present, manifested by increased redness of the skin. It must be stated that when the redness of the original lesion is at all bright, it is next to impossible to distinguish the flare. When this is the case, the best way to perform the test is to prick the histamine solution just inside the border. In the nonleprotic lesion, the flare appears on the adjacent portion of the skin outside the border, whereas there is no such flare extending from the macule in early leprosy.

SUMMARY

1. The histamine test has been found to be a fairly reliable clinical test in differentiating the patches characteristic of the early stages of leprosy from nonleprotic macules.

2. This test is "positive" (the flare is absent) in the large majority of the bacteriologically negative leprotic macules tested.

3. The method of performing the test is described and its limitations mentioned.

THE FLY EUTRIXOPSIS JAVANA TOWNSEND (DIPTERA, TACHINIDÆ), A PARASITE OF THE BEETLE LEUCOPHOLIS IRRORATA IN OCCIDENTAL NEGROS, PHILIPPINE ISLANDS

By A. W. Lopez

Chief Entomologist, Research Bureau, Philippine Sugar Association

On April 10, 1930, four maggots of the tachinid fly *Eutrixopsis javana* Tns. were found in one specimen of the beetle *Leucopholis irrorata* Chevr.,[1] collected at Hacienda Candelaria, La Carlota, Occidental Negros Province. The maggots pupated April 11 and emerged April 20, a pupal period of nine days. The determination of the flies was made by Dr. J. M. Aldrich, of the United States National Museum, Washington, D. C.

The one specimen returned by Doctor Aldrich is in poor condition, and it is impossible to give a description of it. However, its length is 7 millimeters.

The publication Insecutor Inscitiae Menstruus[2] contains the following description of one male collected at Pelaboean, Ratoe, Java, by Bryant and Palmer.

> Length 5.5 mm. wholly brownish-fulvous, including antennae and palpi; tarsi darker, basal half or more of abdominal segments yellowish. Tegulae tawny-whitish. Wings clear.

The United States Department of Agriculture[3] reports that *E. javana* was unwittingly introduced into the United States from Sapporo, Japan, in 1922, with a shipment of material imported to obtain *Centeter cinerea,* a tachinid parasite of the Japanese beetle *Popillia japonica.* It is stated that the life cycle of *E. javana* apparently corresponds closely to that of *Centeter,* only one generation a year being produced.

[1] Coleoptera, Scarabæidæ, worst cane root-pest in the Philippine Islands.

[2] Nos. 10–12 6 (1918) 166.

[3] Bull. 1429: 19–20, with fig. of *E. javana.*

COMPOSITION OF PHILIPPINE KAPOK-SEED OIL

By AURELIO O. CRUZ and AUGUSTUS P. WEST
Of the Bureau of Science, Manila

ONE PLATE

Kapok-seed oil is obtained from the seeds of the silk-cotton tree (*Ceiba pentandra* Gaertner). Recently we determined the composition of Philippine kapok-seed oil and our results showed that this oil has a composition quite similar to that of American cottonseed oil.

The silk-cotton tree is commonly known as kapok. It is a tropical product and grows in tropical countries at such altitudes as are free from frosts. In general, kapok is especially suited to tropical lowlands. It is widely distributed in the Philippines. The kapok tree is slender and usually has a height of about 15 meters or less. The branches are borne in horizontal whorls that are very characteristic.

The kapok fruit is a capsule containing black seeds embedded in fine silky hairs, or floss. The kapok fibers, or floss, surrounding the seeds are soft, elastic, and immune to moths. Kapok floss has the property of being impermeable to moisture and is also extremely buoyant. For this reason kapok is used extensively for the manufacture of buoys, life belts, and life-saving jackets. The chief use of kapok is for stuffing cushions, pillows, mattresses, and similar articles. It is well adapted for this purpose on account of its lightness, its springy or resilient nature, and its nonhygroscopic and nonabsorbent characteristics. Kapok floss is superior to most other flosses in resiliency and consequently is more valuable for stuffing purposes. It has been used considerably for making "down" quilts, which are about as good as "eider down" quilts but much cheaper.

Kapok trees may be grown conveniently with other crops in mixed plantation cultivation. The cultivation of crops under kapok is quite practical because the few leaves and branches of the kapok tree produce very little shade.

Recently there have appeared several articles that give an excellent account of the cultivation of kapok, the harvesting, ginning, yields, insect pests, etc.[1]

Kapok trees begin to bear fruit in about four years, and when seven years old they may yield about 500 pods per tree. The yield naturally varies with the location and other factors. Under favorable conditions much larger yields are obtained. The number of pods required to produce a pound of clean floss is said to average about 100.

Several years ago Philippine kapok appeared to be a very prosperous and promising industry. Like other products, however, the value of kapok has decreased very considerably during the recent financial depression. In 1927 the amount of kapok exported from the Philippines[2] was 330,174 kilograms and the value was 325,770 pesos. During 1929 there were exported 330,312 kilograms but the value was only 64,338 pesos. Probably when trade conditions are again adjusted kapok will return to approximately normal values.

High-grade kapok-seed oil serves as an edible oil. The lower grades are suitable for soap making and other purposes for which low-grade cottonseed oil is employed. The oil cake left after expression of the oil may be used for live-stock food or fertilizer.

According to Lewkowitsch[3] kapok-seed oil is made in Holland from seeds imported from Java. The oil gives color reactions similar to those of cottonseed oil.

EXPERIMENTAL PROCEDURE

Philippine kapok pods, *Ceiba pentandra,* consist of about 51 per cent of husk and core, 32 per cent of seeds, and 17 per cent of floss. One pod weighs about 32 grams and gives an average of about 149 seeds, which weigh about 10 grams.

The Philippine kapok seeds used in this investigation were kindly given to us by Dr. Manuel Roxas, director, Bureau of Plant Industry. The seeds were ground in a mill after which they were cold pressed to obtain the kapok oil. The oil was purified by treating successively with 2 per cent Kieselguhr, Suchar, and talcum powder. This treatment removes vegetable

[1] Grist, D. H., Malayan Agr. Journ. 11 (1923) 3. Saleeby, M. M., The Kapok Industry, Bull. Philip. Bur. Agr. 26 (1922). Bull. Imp. Inst. 24 (1926) 18.

[2] Annual Report, Insular Collector of Customs, Manila (1928 and 1930).

[3] Chemical Technology and Analysis of Oils, Fats, and Waxes 2 (1922) 187.

fibers and colloidal matter and produces a brilliantly clear yellow oil with a slightly greenish tinge. The yield of oil calculated on a moisture-free basis was found to be about 25 per cent.

The constants of this sample of Philippine kapok-seed oil are given in Table 1.

TABLE 1.—*Physical and chemical constants of Philippine kapok-seed oil.*

Specific gravity at $\frac{30°}{4°}$ C.	0.9109
Refractive index at 30° C.	1.4678
Iodine number (Hanus)	95.6
Saponification value	192.1
Unsaponifiable matter (per cent)	0.78
Acid value	7.39
Saturated acids, determined (per cent)	21.73
Unsaturated acids plus unsaponifiable matter, determined (per cent)	72.62
Saturated acids, corrected (per cent)	18.64
Unsaturated acids, corrected (per cent)	75.71
Iodine number of unsaturated acids plus unsaponifiable matter	123.4
Iodine number of unsaponifiable matter	82.4
Iodine number of unsaturated acids (calculated)	123.9

The saturated and unsaturated acids that occur as glycerides in Philippine kapok oil were separated by the lead-salt-ether method [4] in accordance with the suggestions of Baughman and Jamieson.[5] The results are recorded in Table 2.

TABLE 2.—*Separation of saturated acids from the unsaturated acids in Philippine kapok-seed oil by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated [a] acids (determined).	Saturated acids (determined).	Unsaturated acids (corrected).	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	9.7005	7.0033	2.1209	72.20	[b] 21.86	75.25	18.81
2	11.5115	8.4079	2.4870	73.04	[c] 21.60	76.17	18.47
Mean				72.62	21.73	75.71	18.64

[a] Iodine number (Hanus) of unsaturated acids plus unsaponifiable matter, 123.4.
[b] Iodine number (Hanus), 17.2.
[c] Iodine number (Hanus), 17.9.

The unsaturated acids separated from kapok oil by the lead-salt-ether method were treated with bromine and converted into their bromo-derivatives. No ether-insoluble hexabromide was obtained, thus showing the absence of linolenic acid. The com-

[4] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

[5] Cotton Oil Press 6 (1922) 41. Journ. Am. Chem. Soc. 42 (1920) 2398.

position of the mixed unsaturated acids, which occur as glycerides in kapok oil, was calculated from the iodine number of the unsaturated acids. The results are recorded in Table 3. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

TABLE 3.—*Percentage composition of the unsaturated acids of kapok-seed oil and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.[a]	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	37.02	28.03	29.29
Oleic	62.98	47.68	49.83
Total	100.00	75.71	79.12

[a] Calculated iodine number of the pure unsaturated acids was 123.9.

Saturated acids.—The saturated acids were separated from Philippine kapok oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters (83.97 grams), which were yellow, were distilled under diminished pressure. A preliminary distillation at about 3 millimeters pressure was made. The esters (83.93 grams) were then redistilled at 3 millimeters pressure. Data on the distillation of the esters are given in Tables 4 and 5.

TABLE 4.—*First distillation of the methyl esters of the saturated acids; pressure, 3 millimeters; 83.97 grams of esters distilled.*

Fraction.	Temperature.	Pressure.	Weight.
	°C.	*mm.*	*g.*
A	163–167	3	19.43
B	167–170	3	19.98
C	170–174	3	17.07
D	174–196	3	22.34
Residue			5.10
Total			83.92

TABLE 5.—*Second distillation of the methyl esters of the saturated acids; pressure, 3 millimeters; 83.92 grams of esters redistilled.*

Fraction.		Temperature.	Pressure.	Weight.
From first distillation.	Second distillation.			
		°C.	mm.	g.
A	1	163–167	3	21.19
B and C	2	167–169	3	33.04
D	3	169–175	3	13.00
Residue	4	175–192	3	8.99
	5	192–222	3	5.94
	Residue			1.67
Total				83.83

In Table 6, are given the analyses of fractions obtained in the second distillation of methyl esters. From the data (Table 6), there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 7 and were calculated in accordance with the methods outlined by Baughman and Jamieson in their investigations of Hubbard squash-seed oil [6] and also American cottonseed oil.[7]

In Table 8 is given the composition of the mixed saturated acids and the glycerides in the original sample of kapok-seed oil corresponding to these acids.

TABLE 6.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*

Fraction.	Iodine number.[a]	Saponification value.[b]	Mean molecular weight of mixed esters.	Composition of mixed esters.		Mean molecular weight of saturated esters.
				Saturated	Unsaturated.	
				Per cent.	Per cent.	
1	5.93	208.5	269.1	94.95	5.05	267.8
2	9.73	204.9	273.8	91.72	8.28	271.9
3	21.75	202.7	276.8	81.49	18.51	272.9
4	37.39	194.2	288.9	68.18	31.82	285.9
5	39.99	184.8	303.6	65.97	34.03	308.2

[a] Calculated iodine number of unsaturated methyl esters was 117.5.
[b] Calculated saponification value of unsaturated methyl esters was 190.0.

[6] Journ. Am. Chem. Soc. 42 (1920) 156.
[7] Journ. Am. Chem. Soc. 42 (1920) 1197.

TABLE 7.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction.	Acid.							
	Myristic.		Palmitic.		Stearic.		Arachidic.	
	Per cent.	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*
1	7.96	1.69	82.02	17.38	--------	--------	--------	--------
2	--------	--------	82.00	27.09	4.99	1.65	--------	--------
3	--------	--------	70.09	9.11	7.21	0.94	--------	--------
4	--------	--------	28.64	2.58	36.20	3.25	--------	--------
5	--------	--------	--------	--------	40.87	2.43	22.10	1.31
Residue [a]	--------	--------	--------	--------	--------	--------	--------	1.59
Total	--------	1.69	--------	56.16	--------	8.27	--------	2.90

[a] Residue assumed to be methyl arachidate.

TABLE 8.—*Saturated acids.*

Acid.	Mixture of saturated acids.			Glycerides in original oil.
	Weight.	Composition.	Proportion in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Myristic	1.69	2.45	0.46	0.49
Palmitic	56.16	81.37	15.17	15.91
Stearic	8.27	11.98	2.23	2.33
Arachidic	2.90	4.20	0.78	0.81
Total	69.02	100.00	18.64	19.54

The composition of Philippine kapok-seed oil is given in Table 9. There is also included for comparison the analysis of American cottonseed oid.

TABLE 9.—*Composition of Philippine kapok-seed oil compared with American cottonseed oil.*

Constituent.	Philippine kapok-seed oil.	American cottonseed oil.[a]
Glycerides of:		
Unsaturated acids—	*Per cent.*	*Per cent.*
Oleic	49.8	35.2
Linolic	29.3	41.7
Saturated acids—		
Myristic	0.5	0.3
Palmitic	15.9	20.0
Stearic	2.3	2.0
Arachidic	0.8	0.6
Unsaponifiable matter	0.8	---------
Total	99.4	99.8

[a] Composition determined by J. S. Jamieson and W. F. Baughman, Journ. Am. Chem. Soc. 42 (1920) 1197.

The determined iodine number of Philippine kapok-seed oil was found to be 95.6 and the determined saponification value 192.1. The calculated iodine number is 93.8 and the saponification value 191.3. The iodine and saponification values calculated from the composition of the oil agree very closely with the determined values.

SUMMARY

Kapok floss is an excellent material for stuffing cushions, pillows, mattresses, buoys, life-saving jackets, and similar articles. It is well adapted for this purpose on account of its lightness, its springy or resilient nature, and its nonhygroscopic and nonabsorbent characters.

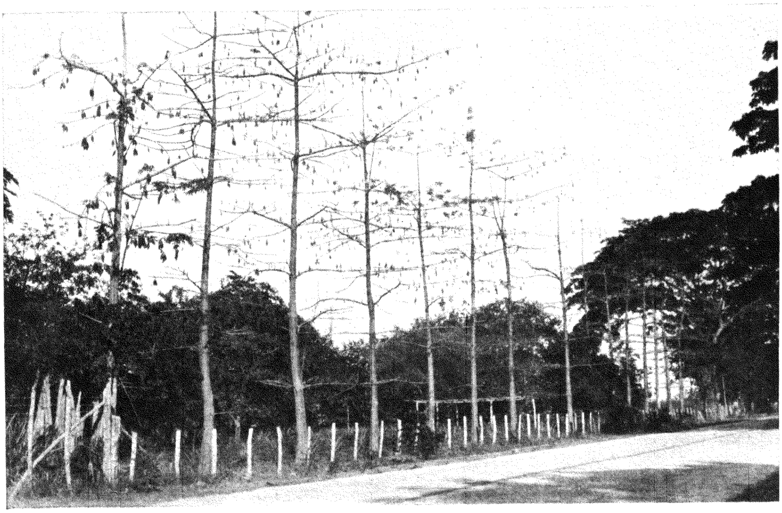
Kapok can be grown in the Philippines conveniently with other crops in mixed plantation cultivation.

The composition of Philippine kapok-seed oil has been determined, and the results (Table 9) indicate that the Philippine oil has a composition very similar to that of American cottonseed oil.

The percentage of linolic and palmitic glycerides is slightly higher in the cottonseed oil than in the kapok oil. The kapok-seed oil has a higher percentage of oleic glyceride than the cottonseed oil, while the percentage of the other glycerides is about the same.

Since Philippine kapok floss is superior to most other flosses and kapok seeds yield an oil of high quality and of about the same composition as American cottonseed oil, it would seem that there are promising prospects for the development of kapok cultivation in the Philippines under normal trade conditions.

ILLUSTRATION



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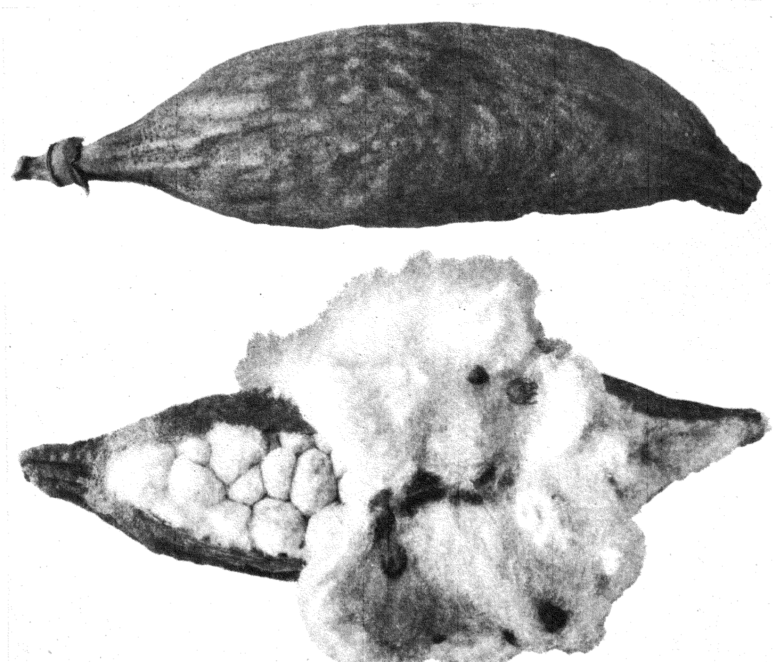

2

PLATE 1. PHILIPPINE KAPOK TREES AND SEED PODS.

THE SKELETON OF THE TIMARAU

By Manuel D. Sumulong

Of the College of Veterinary Science
University of the Philippines
Los Baños, Laguna

THREE PLATES AND FOUR TEXT FIGURES

This paper records some observations on the characteristic features of the skeleton of the full-grown timarau (also spelled timerau and tamarao), a wild species of the family Bovidæ, confined to Mindoro Island, and the largest indigenous mammal of the Philippines. A careful search of the literature on hand has shown nothing about the internal features of this animal. With the hope of partially filling this gap in our knowledge the present study was undertaken.

In the following account an attempt will be made to point out where the skeleton of the animal in question differs from those of the carabao and the cow, making the descriptions of the individual bones comparative, where comparison is possible.

Concerning the habitat, size, and external features of this animal, Steere (1888) states in part:

> I have been in the interior of the little-known island of Mindoro, and have had the satisfaction of procuring specimens of a strange animal there, which, though generally talked of throughout the Philippines, is little known to scientific men. This is the "Tamaron". From the native reports I could make out nothing, but that it was a large fierce beast with sharp horns, which attacked all who came near it . . .
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> In Mindoro I procured three full-grown individuals (two males and one female) of the "Tamaron," and have preserved the skins and skeletons . . . General color of the skin and hair black, hair short and rather fine. A grayish-white stripe running from near the inner corner of the eye towards the base of the horn (this stripe three inches long by one inch wide), a grayish-white spot above each hoof on all feet, a grayish-white patch on inner side of lower foreleg; skin and hair of groin white; bare skin of nose and lips black; horns and hoofs black; tips of horns pointed and polished; horns triangular, with a tendency in the bulls towards thickening and flattening at the base; lower part of the horns with deep irregular pits; several of the last vertebrae of the tail aborted.
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> Size of No. 1: An old bull: length from point of nose to tip of tail eight feet one inch; length of tail one foot five inches; length of tassel of hairs at end of tail two and a half inches; height at shoulder three feet six

inches; from breast-bone to sole of fore foot one foot eight inches; length of horn one foot two inches; circumference of horns at base thirteen inches; horns distance apart at base one and a half inches, at points ten inches; length of head, before skinning, one foot four inches.

Montellano (1929) describes the timarau as follows:

The tamaraw is much like the domesticated carabao, except in size, shape, and size of horns, and conformation of the body. The tamaraw is smaller. The horns are rather short and straight, point vertically upward, and gradually taper to a sharp point admirably adapted for fighting. The body is lighter and shallower, and is better adapted to rapid movement than is that of the domesticated carabao.

These animals, however, are not the ancestors of the wild carabaos found elsewhere in the Philippines, and in Borneo and other neighboring islands, and in Southern Asia.

According to Sclater (1888), Steere proposed to call this species *Anoa mindorensis,* because of its very close resemblance to the *Anoa* of Celebes; but *Bubalus mindorensis,* as proposed by Heude (1888), seems to have been finally accepted. Meyer (1878) is of the opinion that the timarau is entirely different from the *Anoa* of Celebes. Bartlett as well as Gray (1878) believes that it is but a "small variety of the common Manila or water Buffalo." As reported by "Péres de la Campagnie de Jesus (1888)," it is not at all a type of ordinary buffalo. Their report asserts that a buffalo that has escaped from its owner and has become wild for a long time will never produce a timarau. This agrees with the observation of Steere that the timarau is distinctly different from the so-called "carabao cemaron," a wild carabao found in the Philippines, especially in Luzon.

Mention of the timarau as a source of food supply has been made by Miller (1912) in his study of the Mangyans of Mindoro.

In the preparation of this paper the previous work of the writer (1926) on the skeleton of the carabao (*Bubalus bubalis*), the Filipino beast of burden, was freely consulted.

MATERIAL

The data presented here were obtained from a thorough study of the mounted skeleton of an adult timarau in the anatomical museum of the College of Veterinary Science, University of the Philippines, and of another in the museum of the University of Santo Tomas, Manila. So far as the writer is aware these are the only mounted skeletons of this animal in the Philippines. The skeleton at Santo Tomas University is

incomplete, the mandible as well as some of the small bones of the limbs being lacking, and no data could be obtained as to the history of the animal from which it was prepared. The specimen at the College of Veterinary Science is a complete articulated skeleton of an adult timarau which, so far as the writer could recall, was presented to the College in 1916 by an American gentleman with the request that it be sacrificed.

OSTEOLOGY

The following are the bones of the various regions of the skeleton of the timarau:

THE AXIAL SKELETON

A. The Skull.
- 1. Bones of the cranium.
  - *a*. Single bones.
    1. Occipital.
    2. Sphenoid.
    3. Ethmoid.
  - *b*. Paired bones.
    1. Interparietal.
    2. Parietal.
    3. Frontal.
    4. Temporal.
- 2. Bones of the face.
  - *a*. Single bones.
    1. Vomer.
    2. Hyoid.
    3. Mandible.
  - *b*. Paired bones.
    1. Maxilla.
    2. Premaxilla.
    3. Nasal.
    4. Malar.
    5. Lacrimal.
    6. Pterygoid.
    7. Palatine.
    8. Dorsal turbinate.
    9. Ventral turbinate.

B. The Trunk.
- 1. The vertebral column.
  - *a*. Cervical vertebræ, 7.
  - *b*. Thoracic vertebræ, 13.
  - *c*. Lumbar vertebræ, 6.
  - *d*. Sacral vertebræ, 5.
  - *e*. Coccygeal vertebræ, 15.
- 2. The thorax.
  - *a*. Ribs (both sides), 26.
  - *b*. Sternum (7 sternebræ), 1.

THE APPENDICULAR SKELETON

A. Bones of the Thoracic, or Pectoral, Limb.
  a. Shoulder.
    1. Scapula (both sides), 2.
  b. Arm.
    1. Humerus (both sides), 2.
  c. Forearm.
    1. Radius (both sides), 2.
    2. Ulna (both sides), 2.
  d. Manus.
    1. Carpus (both sides), 12.
    2. Metacarpus (both sides), 2.
    3. Digits.
      a. Phalanges (both sides), 20.
      b. Sesamoids (both sides), 12.

B. Bones of the Pelvic Limb.
  a. Pelvic girdle.
    1. Os coxæ (both sides), 2.
  b. Thigh.
    1. Femur (both sides), 2.
  c. Leg.
    1. Tibia (both sides), 2.
    2. Fibula (both sides), 2.
    3. Patella (both sides), 2.
  d. Pes, or hind foot.
    1. Tarsus (both sides), 10.
    2. Metatarsus (both sides), 4.
    3. Digits.
      a. Phalanges (both sides), 20.
      b. Sesamoids (both sides), 12.

In the preceding enumeration mandible, hyoid, and sternum are regarded as single bones, and the os coxæ is not divided into its original parts—ilium, ischium, and pubis. The visceral or splanchnic bones as well as the auditory ossicles are not included.

For the purpose of giving an idea of the difference in size between the skeleton of the timarau and that of the carabao, measurements of the various parts of the mounted skeleton of the timarau of the College of Veterinary Science and that of a medium-sized adult carabao were taken. The length or height of the flat and long bones of both the thoracic and pelvic limbs were likewise determined. The results are given in Tables 1 and 2.

TABLE 1.—*Showing the measurements of the various segments or regions of the articulated skeleton of a timarau and of a medium-sized carabao.*

[Measurements in centimeters.]

Region.	Length.		Height.		Width.		Depth.		Circumference.		Excess in favor of carabao.
	Carabao.	Timarau.	Carabao.	Timarau.	Carabao.	Timarau.	Carabao.	Timarau.	Carabao.	Timarau.	
Vertebral column	175.0	123.0									52.0
Tail	68.0	35.0									33.0
Skull	50.5	35.5									15.0
					20.0	14.5					5.5
							30	21.5			8.5
Horn core	34.0	15.5									18.5
									28	15	13.0
Between bases of horn cores					17.5	7.5					10.0
Between points of horn cores					73.0	21.5					51.5
Thoracic limb			115	82							33.0
Pelvic limb			118	85							33.0

TABLE 2.—*Showing the height or length of the individual long and flat bones of the appendicular skeleton of a timarau and of a medium-sized carabao.*

[Measurements in centimeters.]

Thoracic limb.				Pelvic limb.			
Bone.	Carabao.	Timarau.	Excess in favor of carabao.	Bone.	Carabao.	Timarau.	Excess in favor of carabao.
Scapula	34.0	22.5	11.5	Os coxæ	48.0	32.0	16.0
Humerus	27.5	20.0	7.5	Femur	38.0	28.0	10.0
Radius	29.5	21.0	8.5	Tibia	32.0	24.5	7.5
Ulna	37.0	29.5	7.5	Large metatarsal	20.0	14.5	5.5
Large metacarpal	18.0	12.0	6.0	First phalanx	6.5	5.0	1.0
First phalanx	5.5	4.5	1.0	Second phalanx	4.5	3.5	1.0
Second phalanx	3.5	3.0	0.5	Third phalanx	7.5	4.5	3.0
Third phalanx	6.5	4.0	2.5				

The distance between the level of the foramen magnum and that of the posterior aperture of the sacral canal constitutes the length of the vertebral column indicated in the table. The length of the skull here was measured from the nuchal crest to the central incisor teeth; the width refers to the broadest part of its frontal surface, measuring along an imaginary line

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connecting the two supraorbital foramina. The depth refers to the broadest part of its lateral surface including the mandible, and was determined by measuring the distance between the angle of the mandible and the level of the most prominent part of the frontal region just in front of the base of the horn core. The height of the anterior limb constitutes the distance, in a straight line, between the highest point of the anterior or cervical angle of the scapula and the ground plane, whereas that of the posterior limb, is the distance between the highest point of the tuber coxæ and the ground plane.

THE SKULL

BONES OF THE CRANIUM

Occipital.—The occipital bone is very much less extensive than that of the carabao or ox. The external surface of the squamous and lateral parts, when taken as a whole, instead of being flattened as in the carabao, is convex transversely. The nuchal crest is markedly better developed, but the external occipital protuberance is only represented by a rather faint elevation, which is flanked on either side by a depression. The median occipital crest is only represented here by a low ridge and does not reach the upper border of the foramen magnum, fading out halfway between its margin and the external occipital protuberance. It terminates into a rather deep depression bounded on either side by a rounded muscular eminence formed by the fusion of the squamous and lateral parts. The foramen magnum is comparatively smaller, and its roof is perforated by three small foramina located a short distance from its margin. The paramastoid processes are short, being about one-half the length of those of the carabao. The basilar part is likewise relatively shorter and does not form with the body of the sphenoid prominent ventral tubercles. The edge dividing the articular surface of the condyle into an upper and a lower facet is better defined. Except in size the hypoglossal and mastoid foramina present no striking features.

Sphenoid.—The body of the sphenoid is narrow and short and the temporal and orbital wings are less extensive. As in the carabao there is a deep pituitary fossa and a very well-developed dorsum sellae. The foramen orbito-rotundum as well as the foramen ovale presents no special features other than its small size. The pterygoid crest is not well developed.

Ethmoid.—The ethmoid and its cells are well developed, differing only from those of the carabao in size. No attempt was

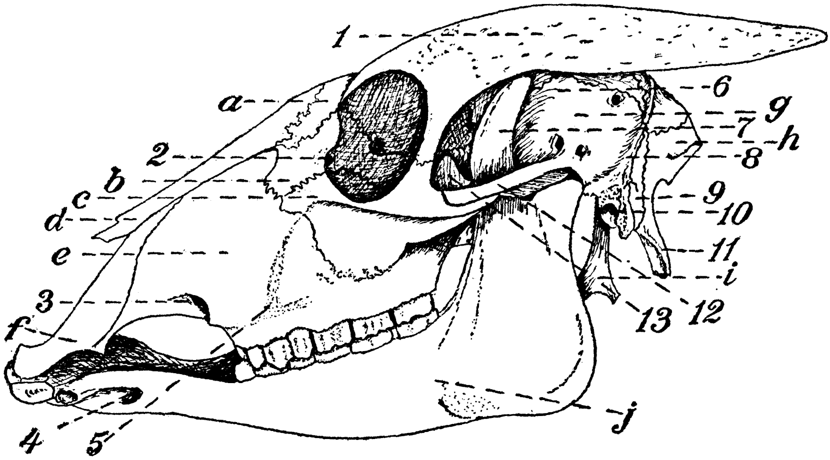

FIG. 1. Lateral view of the skull of the timarau. *a,* Part of the frontal bone; *b,* lacrimal; *c,* malar; *d,* nasal; *e,* maxilla; *f,* premaxilla; *g,* temporal; *h,* occipital; *i,* hyoid; *j,* mandible; *1,* horn core; *2,* lacrimal fossa; *3,* infraorbital foramen; *4,* mental foramen; *5,* maxillary tuberosity; *6,* temporal fossa; *7,* coronoid process of the mandible; *8,* temporal crest; *9,* mastoid process; *10,* external acoustic meatus; *11,* paramastoid process; *12,* zygomatic arch; *13,* lacrimal bulla.

made to discover an air sinus in its perpendicular plate, which is sometimes observed in carabao.

Interparietal.—The interparietal is completely fused behind with the supraoccipital. Its external surface is smooth and flat instead of convex as in the carabao; the cranial aspect is like that of the same bone in the carabao or cow, carrying no distinct tentorium osseum.

Parietal.—The external parietal crest is curved and better defined than that of the carabao. This crest distinctly divides the parietal bone into an upper horizontal part and a vertical lower part. From the union of the horizontal parts of the two parietal bones results a central plate whose anterior part is triangular and concave. This is the only part of the parietals that is visible when the skull is viewed directly from the front. The posterior part that lies behind the line joining the bases of the horn cores of the frontal bones is more or less quadrilateral in outline, presenting a comparatively smooth and slightly convex outer surface which looks directly upward. The lower vertical part that forms part of the medial wall of the temporal fossa is slightly convex from the front backward, and it is not concave from above downward as in the case of the carabao and cow. Its anterior border is nearer to the frontal crest than in the carabao.

Frontal.—The frontal bone is relatively narrower transversely than in the carabao. Externally the nasofrontal part is more concave in front, but nearly flat behind. There is no indication of the frontal eminence at the junction of its posterior border and the parietal bone. The horn cores are relatively smaller, shorter, and less curved than in the carabao. They are more or less three sided and taper to a blunt point. They are directed almost straight backward, turning toward each other moderately at the points; they also run a little downward bringing the ends to lie in the line of the orbit. The supraorbital foramen is relatively smaller and is placed higher. The groove leading from it is narrower but deeper. The supraorbital process is weaker but relatively longer than in the carabao or cow. The orbital part as well as the temporal part of the bone is less concave and extensive.

Temporal.—The temporal bone of the timarau is characterized by the following features: The temporal crest is poorly developed, and the zygomatic process is not as strong as in the carabao. The external aspect of the part of the squamous temporal that concurs with the parietal in the formation of the medial wall of the temporal fossa is moderately convex, instead of being concave as in the carabao or cow. The postglynoid process is very poorly developed. The posterior process forms a distinct muscular eminence behind the external acoustic process. Aside from the difference in size, the muscular process, the bulla ossea and the acoustic process present no other features of interest.

BONES OF THE FACE

The bones of the face, aside from the difference in size, present only a few important special features as compared with those of the carabao.

Maxilla.—The facial tuberosity of the maxilla is only represented by a slightly elevated rough area, placed about an inch above the alveolus of the third premolar tooth; from it extends backward and upward an ill-defined ridge which gradually fades out and terminates at the junction of the maxilla and the malar bone. The infraorbital foramen is relatively small and is located just in front of the level of the alveolus for the first premolar tooth. The maxillary tuberosity is very poorly developed and very much compressed laterally; it bears a short blunt-pointed process that projects upward and backward. As in the carabao this bone does not form any defect in its nasal

wall for it directly articulates with the nasal bone, and the interval they form is completely occupied by the posterior extremity of the nasal process of the premaxilla. The anterior part of the palatine process is narrow and is deeply concave transversely. The maxillary foramen is slitlike and small.

Premaxilla.—The body of the premaxilla is relatively thin and small, otherwise it resembles that of the carabao; the foramen incisivum is represented by a notch. The palatine process is practically as long as in the carabao and its posterior end is overlapped by the anterior end of the vomer; it is deeply grooved in the nasal surface for the reception of the ventral edge of the vomer. The palatine fissure is narrow. The nasal process is well developed and more or less prismatic; its posterior end completely occupies the interval of the nasal and maxillary bones.

Palatine.—The palatine bone closely resembles that of the carabao.

Nasal.—The nasal bone, except in size, does not present many important differential features that will attract attention. The lower end of this bone is divided by a notch into an outer and an inner process; the latter is the smaller, instead of being the larger, as is the case in the carabao.

Lacrimal.—The bulla of the lacrimal bone is proportionately larger. In other respects this bone resembles that of the carabao.

Malar.—The facial part of the malar bone bears a less distinct ridge as compared with that of the carabao. This ridge is apparently the continuation of the ill-defined crest of the maxilla. The region behind the crest is less concave dorsoventrally. The upper extremity of the bone is bifurcate, the upper branch being relatively shorter and weaker than in that of the carabao or cow. The bone does not curve very much laterally.

Aside from the difference in size the pterygoid bone does not materially differ from the same bone in the carabao.

Vomer, hyoid, and turbinate.—The vomer, hyoid, and turbinate bones resemble those of the carabao practically in all respects.

Mandible.—The mandible likewise resembles very closely that of the carabao in general form. The outer aspect of the perpendicular part of the ramus, however, is comparatively smooth, presenting very few and less salient muscular ridges.

THE SKULL AS A WHOLE

The skull of the timarau resembles in most respects that of the carabao. The upper half of the frontal surface is relatively narrower than in the latter animal, and it presents a slightly depressed central area. The roof of the cranium is almost flat. There is no indication at all of the so-called median "frontal eminence." The supraorbital foramen is placed higher and the horn cores are more or less three-sided and comparatively smaller and shorter; they run almost straight backward and a little downward. The zygomatic arches and supraorbital processes do not curve outward as much as in the carabao.

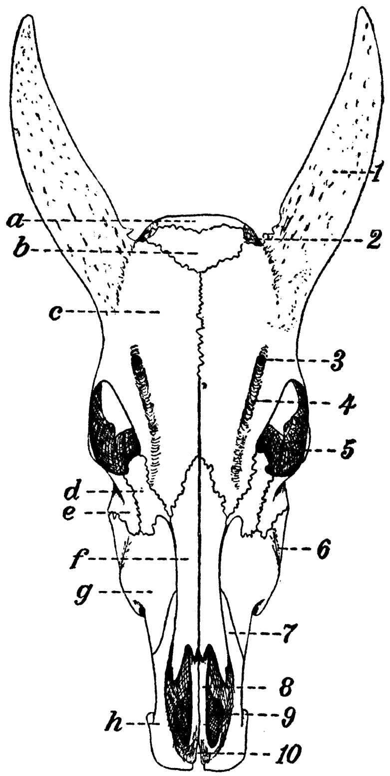

FIG. 2. Frontal view of the skull of the timarau. *a*, Fused interparietal and supraoccipital; *b*, fused dorsal or horizontal parts of the parietals; *c*, frontal bone; *d*, lacrimal; *e*, malar; *f*, nasal; *g*, maxilla; *h*, premaxilla; *1*, horn core (processus cornus); *2*, external parietal crest; *3*, supraorbital foramen; *4*, supraorbital groove; *5*, orbit; *6*, maxillary tuberosity; *7*, nasal process of premaxilla; *8*, palatine process of premaxilla; *9*, palatine fissure; *10*, palatine (notch) cleft.

The following are the most salient differential features of the lateral surface: The facial tuberosity is only represented by a slightly raised rough area, and the curved crest that extends from it is ill-defined and incomplete. The temporal fossa encroaches more on the posterior surface; it is relatively shallower than in the carabao and its medial wall is moderately convex from before backward. The external parietal crest, which limits the fossa behind, is better defined. At the junction of the anterior extremity of the body of the maxilla and the nasal process of the premaxilla is a thin triangular plate of bone projecting downward and outward.

The cranial part of the basal surface is relatively narrower than in the carabao, and the tubercles in front of the occipital condyles as well as the ventral tubercles at the junction of the occipital and sphenoid bones are rather poorly developed. The

posterior nares are completely divided medially by the vomer. The anterior palatine foramina are also found at the junction of the horizontal part of the palatine bone and the palatine process of the maxilla. The triangular plate of bone resulting from the union of the anterior extremity of the body of the maxilla and the nasal process of the premaxilla is also visible in this surface.

The posterior surface (nuchal surface) is distinctly divided by a better-developed nuchal crest into an upper and a lower area. The upper area is formed by the frontals, interparietals and supraoccipital; it is more or less quadrilateral in outline and less extensive than the lower one; it is smooth and slightly convex from side to side; and it is separated from the temporal fossa by the parietal crests. The area below the nuchal crest is rough and wide transversely below; the external occipital protuberance consists only of a small rough elevation flanked on either side by a depression. Extending from this elevation is a faint ridge that terminates below into a depression bounded on either side by a rounded muscular eminence formed at the junction of the squamous and lateral parts of the occipital bone. Other features of this surface resemble very closely those of the carabao.

The cranial cavity as well as the nasal cavity, aside from the difference in size, is practically the same as in the carabao. Mention may be made here that no attempt was made to open and study the paranasal sinuses because we did not feel justified in destroying the only mounted skeleton of the timarau in the College.

THE VERTEBRAL COLUMN

The number of bones observed in each region of the vertebral column of the timarau is indicated in the following formula, each region being denoted by its initial letter; C_7 T_{13} L_6 S_5 Cy_{15}. As to the number of bones, the sacral region of the vertebral column of this animal differs from that of the carabao, being made of only four segments or vertebræ, and in the case of the ox the difference lies in the coccygeal region, the number of coccygeal vertebrae in the latter animal varying from 18 to 20.

Cervical vertebræ.—Except in respect to size these bones resemble very closely those of the carabao. With the atlas and axis, however, the following points are noteworthy: The tuberosity of the dorsal arch of the atlas is relatively better developed than in the carabao, resembling very closely that of the ox.

The wings are relatively thinner and less horizontal, and the posterior border of the dorsal arch is deeply notched. The fossa atlantis is shallower. The spinous process of the axis is comparatively weaker and its free border is less tuberous. The intervertebral foramen is placed farther behind, and the foramen transversarium is relatively small. The transverse processes are directed downward, outward, and backward, instead of being horizontal as in the case of the carabao.

Thoracic vertebræ.—As compared with the same bones in the carabao, these vertebræ do not present any striking differential features, save that they are smaller and less voluminous and that the free ends of the spinous processes are less tuberculate. Besides, both the anterior and posterior edges of the spinous processes are straighter and more regular.

Lumbar vertebræ.—Aside from the difference in size these vertebræ do not materially differ from those of the carabao. The mammillary processes of these bones, however, are less prominent and not as tuberous as in the latter animal; and the transverse processes are relatively weaker and their edges are more regular.

Sacrum.—This bone is relatively longer but less voluminous than in the carabao; it is made of five segments or vertebræ as in the ox. It is less arched. The spinous processes are lower, and only those of the second, third, fourth, and fifth vertebræ are completely fused together. The lateral borders are not very thin, sharp, and irregular. The pelvic surface is less concave in both directions, and the central groove is hardly traceable.

Coccygeal vertebræ.—There are only fifteen coccygeal vertebræ. A complete arch is present in the first seven bones, which possess also transverse processes and distinct, though nonfunctional, anterior articular processes. The arches as well as the transverse and articular processes become more or less rudimentary as they are traced backward. It may be remarked here that the transverse processes of the first vertebra resemble very closely those of the last segment of the sacrum both in development and size, so that by casual observation it appears to be a component of the sacrum which has not fused.

THE THORAX

As in the carabao the ribs of the timarau number thirteen pairs—eight sternal and five asternals. They are proportionately shorter, narrower, but more strongly curved than in the

carabao. The necks are relatively shorter, and the facets of the tubercles are not deeply concave. The borders are more regular.

The sternum consists also of seven sternibræ and resembles that of the carabao in general form. It is, however, relatively shorter and placed less obliquely. The first sternebra is not so bent upward, and the thorax is more barrel-shaped than in the carabao or ox.

THE BONES OF THE THORACIC LIMB

Scapula.—The scapula of the timarau resembles very closely that of the carabao in general form, but in size it is relatively smaller. The spinous process is more sinuous and the tuber spinæ is less tuberous and poorly developed. The acromion is hardly recognizable. The supraspinous and infraspinous fossæ are shallower and the anterior border is regular. The tuber scapulæ, as well as its coracoid process, is less pronounced.

Humerus.—As compared with the same bone in the carabao, the humerus of the timarau presents the following features that are worth noticing: It is shorter and less voluminous. The musculospiral groove is deeper; the deltoid tuberosity is more pronounced; the teres tuberosity is ill-defined; the curved line extending from the deltoid tuberosity to the neck is hardly distinguishable; and the nutrient foramen is located about the middle of the medial surface.

Radius and ulna.—Except in point of size and the poorly developed radial tuberosity, the radius and ulna are almost identical with those of

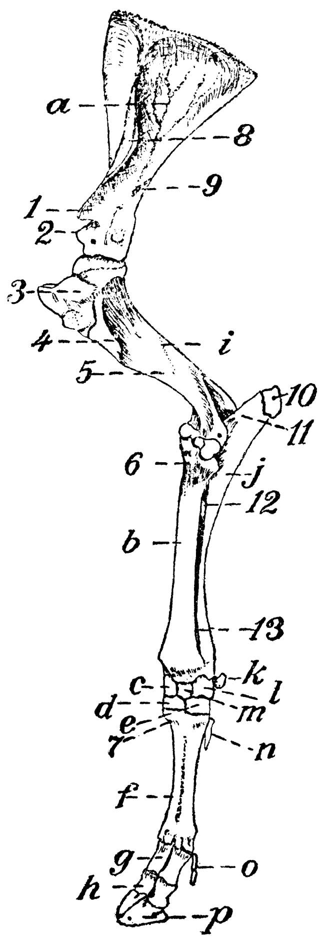

FIG. 3. Lateral aspect of the articulated bones of the thoracic limb of the timarau. *a*, Scapula; *b*, radius; *c*, radial carpal; *d*, fused second and third carpals; *e*, fourth carpal; *f*, large metacarpal; *g*, first phalanx; *h*, second phalanx; *i*, humerus; *j*, ulna; *k*, accessory carpal; *l*, ulnar carpal; *m*, intermediate carpal; *n*, small metacarpal; *o*, bones of the accessory digit; *p*, third phalanx; *1*, rudiment of acromion; *2*, tuber scapulae; *3*, lateral tuberosity of the humerus; *4*, deltoid tuberosity; *5*, musculospiral groove; *6*, radial tuberosity; *7*, metacarpal tuberosity; *8*, tuber spinæ; *9*, nutrient foramen of scapula; *10*, olecranon process; *11*, olecranon fossa; *12*, upper interosseous space; *13*, lower interosseous space.

the carabao. The ulna is rather more slender and less curved in its length.

Carpals.—The carpus consists also of six carpal bones—four in the proximal row and two in the distal row. The bones are very much reduced in size, otherwise they are similar to those of the carabao.

Metacarpals.—As in the carabao, two bones are present in the metacarpus of the timarau, the large metacarpal bone formed by the consolidation of the third and the fourth and the lateral small metacarpal or the fifth metacarpal bone. The large metacarpal is relatively shorter, but it is not very much expanded in its distal part, as is the case in the carabao; its tuberosity (metacarpal tuberosity) is rather poorly developed.

Phalanges and sesamoids.—Aside from the difference in size, the phalanges and sesamoids of the digits—the fully developed third and fourth and the rudimentary second and fifth—correspond almost exactly in general forms and characters with those of the carabao.

THE BONES OF THE PELVIC LIMB

Os coxæ.—The os coxæ correspond almost exactly in general form to those of the carabao. The following differential points, however, are noteworthy: The crest of the ilium is almost straight; the gluteal line is very faint; the psoas tubercle is less pronounced; and the tuber coxæ are less tuberous and massive. The tuber ischii is likewise less massive, and the superior ischiatic spine has fewer and less-developed vertical lines laterally. The conjugate diameter of the anterior aperture or inlet of the pelvis is 16.5 centimeters, while the transverse diameter is 12.5 centimeters.

Femur.—The femur of the timarau differs only from that of the carabao in size, being relatively shorter and less voluminous, in addition to the presence of a rather deep supracondyloid fossa and less-developed supracondyloid crests.

Tibia.—The shaft of the tibia is less curved and the muscular lines (linea muscularis) on the posterior surface are fewer and less distinct. In other respects this bone resembles that of the carabao.

Patella and fibula.—The patella and the fibula are very much reduced in size, but in other features they correspond almost

exactly with those of the carabao.

Tarsals, metatarsals, phalanges, and sesamoids.—The tarsal and metatarsal bones as well as the phalanges and sesamoids of the pelvic limb are likewise almost identical with corresponding bones in the carabao; they present no striking features except their small size.

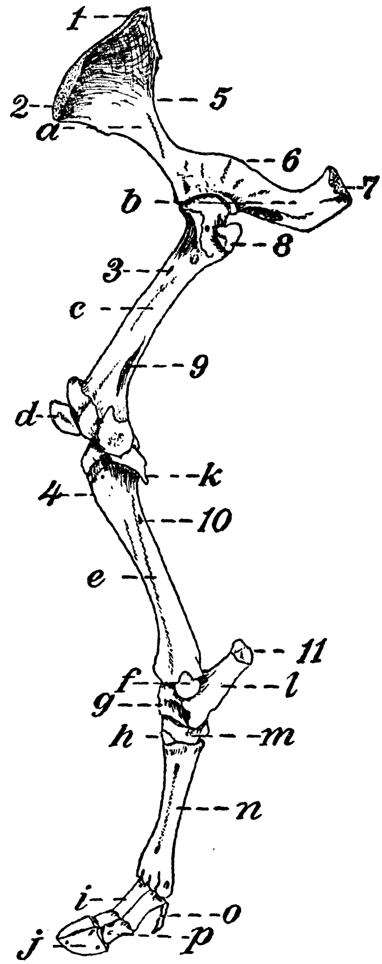

FIG. 4. Lateral aspect of the articulated bones of the pelvic limb of the timarau. *a*, Ilium; *b*, ischium; *c*, femur; *d*, patella; *e*, tibia, *f*, distal end of fibula (lateral malleolus); *g*, tibial tarsal; *h*, fused second and third tarsals; *i*, first phalanx; *j*, third phalanx; *k*, proximal part of fibula; *l*, fibular tarsal; *m*, fused central and fourth tarsals; *n*, large metatarsal; *o*, bones of the accessory digit; *p*, second phalanx; *1*, tuber sacrale; *2*, tuber coxæ; *3*, nutrient foramen of the femur; *4*, crest of tibia; *5*, greater sciatic notch; *6*, superior ischiatic spine; *7*, tuber ischii; *8*, trochanter major; *9*, supracondyloid fossa; *10*, nutrient foramen of tibia; *11*, tuber calcis.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A timarau near Bongabong River, Mindoro. (Photograph by E. A. Heise, 1921.)

2. Timarau *Bubalus mindorensis* Heude, from a living animal in Mehan Gardens, Manila. This species is restricted to Mindoro. (Photograph by Cortes.)

PLATE 2

Lateral view of the mounted skeleton of an adult timarau in the anatomical museum of the College of Veterinary Science, University of the Philippines (Photograph by the College of Agriculture.)

PLATE 3

Anterolateral view of the mounted skeleton of an adult timarau of the anatomical museum of the College of Veterinary Science, University of the Philippines. (Photograph by the College of Agriculture.)

TEXT FIGURES

FIG. 1. Lateral view of the skull of the timarau. *a*, Part of the frontal bone; *b*, lacrimal; *c*, malar; *d*, nasal; *e*, maxilla; *f*, premaxilla; *g*, temporal; *h*, occipital; *i*, hyoid; *j*, mandible. *1*, horn core; *2*, lacrimal fossa; *3*, infraorbital foramen; *4*, mental foramen; *5*, maxillary tuberosity; *6*, temporal fossa; *7*, coronoid process of the mandible; *8*, temporal crest; *9*, mastoid process; *10*, external acoustic meatus; *11*, paramastoid process; *12*, zygomatic arch; *13*, lacrimal bulla.

2. Frontal view of the skull of the timarau. *a*, Fused interparietal and supraoccipital; *b*, fused dorsal or horizontal parts of the parietals; *c*, frontal bone; *d*, lacrimal; *e*, malar; *f*, nasal; *g*, maxilla; *h*, premaxilla; *1*, horn core (processus cornus); *2*, external parietal crest; *3*, supraorbital foramen; *4*, supraorbital groove; *5*, orbit; *6*, maxillary tuberosity; *7*, nasal process of premaxilla; *8*, palatine process of premaxilla; *9*, palatine fissure; *10*, palatine (notch) cleft.

3. Lateral aspect of the articulated bones of the thoracic limb of the timarau. *a*, Scapula; *b*, radius; *c*, radial carpal; *d*, fused second and third carpals; *e*, fourth carpal; *f*, large metacarpal; *g*, first phalanx; *h*, second phalanx; *i*, humerus; *j*, ulna; *k*, accessory carpal; *l*, ulnar carpal; *m*, intermediate carpal; *n*, small metacarpal; *o*, bones of the accessory digit; *p*, third phalanx; *1*, rudiment of acromion; *2*, tuber scapulæ; *3*, lateral tuberosity of the humerus; *4*, deltoid tuberosity; *5*, musculospiral groove; *6*, radial tuberosity; *7*, metacarpal tuberosity; *8*, tuber spinæ; *9*, nutrient foramen of scapula; *10*, olecranon process; *11*, olecranon fossa; *12*, upper interosseous space; *13*, lower interosseous space.

FIG. 4. Lateral aspect of the articulated bones of the pelvic limb of the timarau. *a*, Ilium; *b*, ischium; *c*, femur; *d*, patella; *e*, tibia; *f*, distal end of fibula (lateral malleolus); *g*, tibial tarsal; *h*, fused second and third tarsals; *i*, first phalanx; *j*, third phalanx; *k*, proximal part of fibula; *l*, fibular tarsal; *m*, fused central and fourth tarsals; *n*, large metatarsal; *o*, bones of the accessory digit; *p*, second phalanx. *1*, tuber sacrale; *2*, tuber coxæ; *3*, nutrient foramen of the femur; *4*, crest of tibia; *5*, greater sciatic notch; *6*, superior ischiatic spine; *7*, tuber ischii; *8*, trochanter major; *9*, supracondyloid fossa; *10*, nutrient foramen of tibia; *11*, tuber calcis.

1

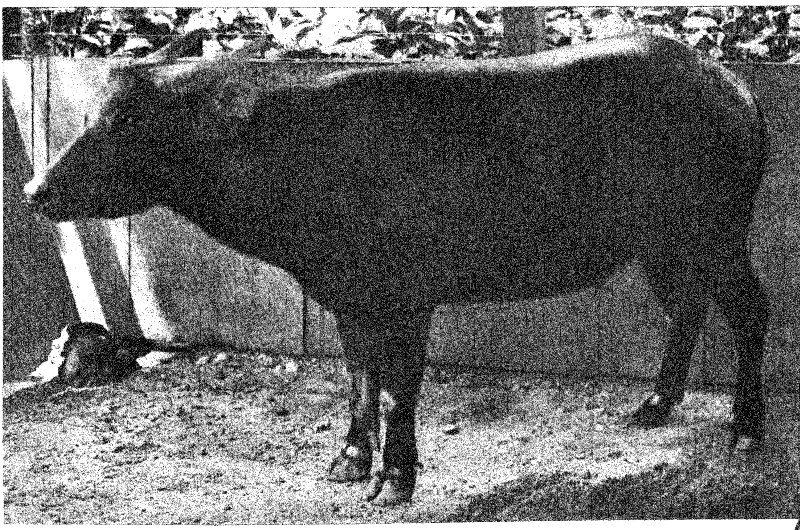

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PLATE 1. TIMARAU, BUBALUS MINDORENSIS HEUDE.

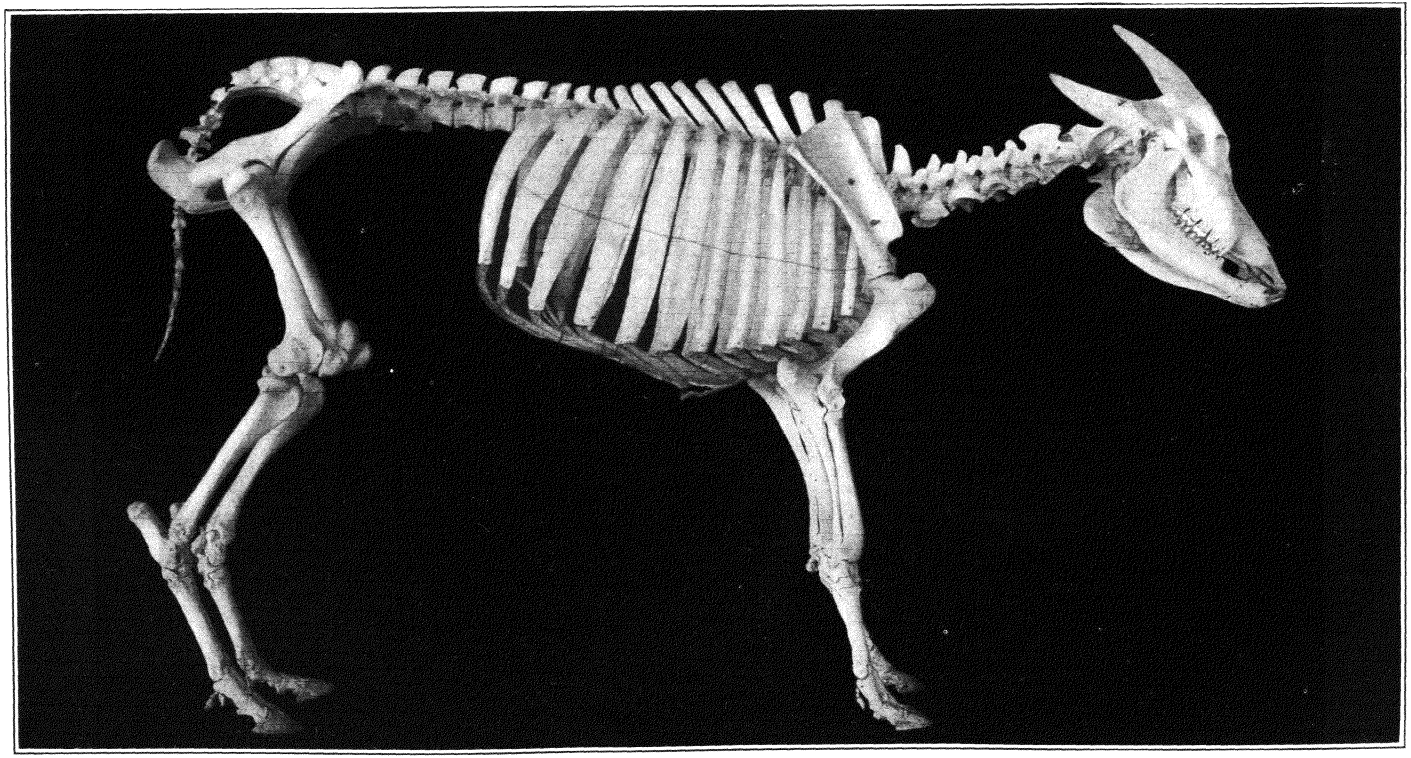

PLATE 2. LATERAL VIEW OF THE MOUNTED SKELETON OF AN ADULT TIMARAU.

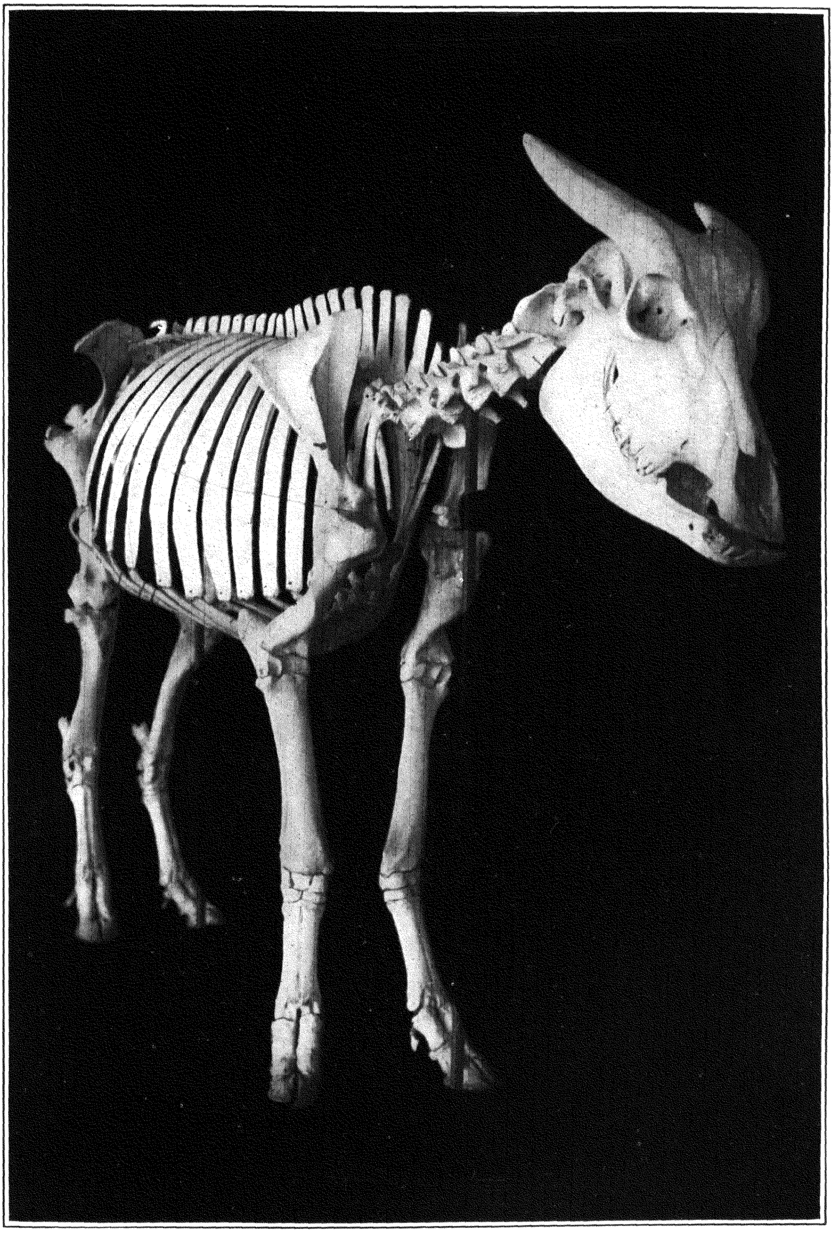

PLATE 3. ANTERO-LATERAL VIEW OF THE MOUNTED SKELETON OF AN ADULT TIMARAU IN THE ANATOMICAL MUSEUM OF THE COLLEGE OF VETERINARY SCIENCE, UNIVERSITY OF THE PHILIPPINES.

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RAT-BITE FEVER IN THE PHILIPPINES

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THREE PLATES

The existence of rat-bite fever (sodoku) in the Philippines has evidently been suspected by a few practicing physicians. Consultation of the literature reveals a clinical case reported by Dr. Manuel Guerrero [1] and another clinical case is reported by José Montes.[2] As far as their reports show, their observations were purely clinical; they did not demonstrate or identify in the suspected cases the presence of the spirochæte that causes the disease.

The object of the present communication is to report a case of rat-bite fever in a native child in Manila in which the causative agent of the disease, *Spirochæta morsus muris*, was demonstrated and identified.

HISTORY OF THE ILLNESS

On January 20, 1931, about 9 a. m., a little girl, 4 years old, named Iluminada Flores, residing at 350 Sevilla, San Nicolas, was brought to the Bureau of Science for Pasteur treatment, after having been bitten by a rat. The patient presented a very conspicuous œdematous swelling of the forehead, the sides of the face, and the neck. The sides of the face were overlaid by distinctly visible maplike red macules. A vivid recollection of

[1] Rev. Filip. de Med. y Farmacia (July, 1917).

[2] Rev. Filip. de Med. y Farmacia 14 (1923) 304.

a graphic description of a case of rat-bite fever in Spain, reported by Pascual Escolano,[3] enabled me to diagnose this case at first sight as rat-bite fever. Lt. Col. Hayashi Hirano, Medical Corps, Imperial Japanese Army, at present in the Bureau of Science, was consulted and gave me very useful suggestions on how to proceed in isolating the causative spirochæte.

The patient was bitten on the forehead by a rat on January 5, 1931, late at night, while in bed. The bite healed quite uneventfully within the next few days. One week after she had been bitten, she developed fever at 6 p. m., which lasted the whole night up to 10 a. m. the following day. She was then free from fever for two days. Fever again appeared at 6 p. m. and lasted three hours. This time the skin around the healed bite, covering an area about the size of a peso coin, was swollen and red. The patient was free from fever for two days. She again developed fever lasting from 6 p. m. to 8 p. m. On January 19, 1931, at 6 p. m., the patient developed fever which lasted two hours. In the meantime the swelling and red spots had gradually extended to include the forehead, the sides of the face, and the sides of the neck, but the patient evidenced no particular discomfort, and continued to play and eat quite as usual.

On January 20, 1931, about 9 a. m., the patient presented the following symptoms:

1. An extensive diffuse, rather firm, œdema of the forehead and the sides of the face and neck; more extensive on the left side of the neck than on the right side.

2. An elongated, irregular, maplike red macule with elevated edges on each side of the face between the ears, posteriorly, and the cheeks, anteriorly, and extending from the level of the eyes above to near the edge of the lower jaw below.

3. A dusky, purplish, discolorization of the forehead was not very conspicuous on account of the brown complexion of the patient and the adhering remains of the ointments applied.

4. A reddish discolorization of the sides of the neck extending from the ears and the angle of the jaw to a little above the clavicle, on the left side, and only half-way this distance on the right side. Purplish blotches here and there on the left side of the neck.

5. A tiny white scar at site of bite, measuring 0.5 centimeter vertically and 0.3 centimeter horizontally, visible on close in-

[3] Rev. Med. y Cir. (1919).

spection, at a point situated at the junction of upper and middle third of the forehead, somewhat to the left of the median line.

6. A marked swelling of the anterior auricular and superior cervical lymphatic glands. A swelling of the supraclavicular lymphatic glands on the left side was also present.

7. All the swollen parts of the face felt warm to the touch, but the patient had no fever at that time.

8. The tongue was clean and the throat and tonsils normal.

9. The heart, the lungs, and the nervous system were normal.

January 21, 1931, 2.30 p. m.—The œdema and swelling of the glands still persist. The macules are now dusky red. An injection of sodium cacodylate combined with strychnine and sodium glycerophosphate was given the patient.

January 22, 1931.—The patient's mother reports that the patient had fever from 8 p. m. yesterday to 5 a. m. this morning. The tongue appears coated and œdema persists. The edges of the erythematous areas on the face and forehead are more elevated and are redder than the rest of the areas. The redness on the neck is less conspicuous now, and the glands are larger and softer. Injection of cacodylate, etc., was given.

January 23, 1931, 2.15 p. m.—The œdema has somewhat subsided. The macules are paler red than before. The glands have reduced in size. Cacodylate, etc., were again injected.

January 24, 1931, 9 a. m.—The œdema has further subsided. The macules are paler and the glands smaller. A blood count was made and the hæmoglobin determined.

January 26, 1931, 2.30 p. m.—The patient is reported to have had fever from 8 p. m. January 24 to 5 a. m. January 25 and now appears quite pale. The macules have a light dusky reddish discolorization, and only the edges of the macules on both sides of the face show a marked red color. The œdema has greatly subsided; there is no redness on the neck. The tongue is still coated. Injection of cacodylate, etc., was given.

January 27, 1931, 2.30 p. m.—The macules have practically disappeared; only a little light red line on both sides of the face laterally to the malar region is still distinctly visible. The tongue is clearing up and the œdema has further subsided. The glands are smaller, but quite palpable. The patient is pale. Cacodylate, etc., were injected.

January 28, 1931, 2.30 p. m.—The patient is still pale, but the tongue is now clean. The little red lines on the face are still conspicuous. The œdema is less though the glands are still palpable. Cacodylate, etc., were given.

January 30, 1931, 2.30 p. m.—The patient's face presents a conspicuous appearance; a red, elevated line can be distinctly traced from a point at the level of the lower margin of the mandible, about one inch distant from the lobe of the ear, upward across the face to the right lower eyelid extending across the bridge of the nose, and following as an exactly symmetric line on the opposite side of the face to the lower margin of the left mandible. This line delimits symmetrical portions of the face, like a mask, the portions above the line being a pale dusky red, quite distinct from the portions of the face situated below the line. The œdema is

practically gone, the glands are smaller, and the tongue is clean; cacodylate, etc., were injected.

January 31, 1931, 9.45 a. m.—The above described line on the face of the patient is still visible, but no longer elevated. The œdema is not noticeable. The glands are still palpable. Cacodylate etc., were injected.

February 2, 1931, 2.30 p. m.—The line on the face is still visible, though not elevated, and on both sides of the face laterally to this line and about 0.75 inch distant from it, there is another red line, the intervening skin between the two lines being pale. The mask appearance is still distinctly visible. The glands are much smaller but still palpable.

February 3, 1931, 8 a. m.—The masklike effect is still present. The glands are smaller.

February 4, 1931, 9 a. m.—The red line described above as delimiting symmetrical portions of the face, has rounded up to include the lower part of the chin. The unaffected portions of the face are now the lower half of the nose, the inner half of the cheeks, and the tip of the chin. This picture is quite similar to that of Escolano's case. On the affected portions of the cheeks alternating red and pale areas of skin are seen, the red lines describing irregular turns inclosing in some places fanciful, flowerlike patches of pale skin. The glands, especially the upper cervical, are still palpable. Cacodylate, etc., were given. Wassermann reaction ++, and Kahn reaction ++++.[4]

February 5, 1931.—The masklike effect is still present, though the redness is less. The red line has bridged over from under the mandible to the left angle of the mouth. The glands are still palpable. Cacodylate, etc., were injected.

February 6, 1931.—The red line has bridged over from under the mandible to the right angle of the mouth; the redness is less. The anterior auricular glands are not palpable now, but the superior cervical glands are still palpable. Cacodylate, etc., were injected.

February 7, 1931.—The redness has greatly faded in all the masklike area. Cacodylate, etc., were injected.

February 9, 1931.—The masklike area is hardly visible. The redness has disappeared; instead, a brownish discolorization now occupies the previously reddish portions of the masklike area. The superior cervical glands are much smaller. Cacodylate, etc., were injected.

February 10, 1931.—A few reddish lines on the cheeks and on the sides of the chin are now seen. The superior cervical glands are still palpable. Cacodylate, etc., were injected.

February 11, 1931.—Reddish blotches are now present on the left temporal region. The superior cervical glands are still palpable. Ten centigrams of myosalvarsan (iso) was administered intramuscularly.

February 12, 1931.—No more reddish blotches anywhere. The patient had fever last night from 7 to 12 p. m. The superior cervical glands are smaller.

February 13, 1931.—The patient looks well. The glands are smaller.

February 16, 1931.—The patient looks well. The glands are still palpable, though greatly reduced.

[4] The serologic reactions were kindly performed by Dr. O. Garcia and read jointly by him and the author.

JANUARY 24, 1931

Hæmoglobin, per cent (Tallquist-Newcomer)[5]	57
Red cells per cubic millimeter	4,750,000
White cells per cubic millimeter	7,100
Differential count:	
Neutrophiles, per cent	60.5
Small lymphocytes, per cent	32.0
Large lymphocytes, per cent	2.0
Mononuclears, per cent	1.5
Eosinophiles, per cent	4.0
	100.0

FEBRUARY 6, 1931

Hæmoglobin, per cent (Tallquist)	50
Red cells, per cubic millimeter	4,370,000
White cells, per cubic millimeter	11,500
Differential count:	
Neutrophiles, per cent	68
Small lymphocytes, per cent	25
Large lymphocytes, per cent	2
Mononuclears, per cent	4
Eosinophiles, per cent	1
	100

February 6, 1931.—Reaction acid; glucose negative, albumin traces. Sediments: Abundant epithelial cells, leukocytes and amorphous urates, few mucous threads and cylindroids. No casts found.[6]

PROCEDURE EMPLOYED TO DEMONSTRATE THE CAUSATIVE AGENT OF RAT-BITE FEVER

A few drops of blood were obtained from the patient's forehead at points near the site of the bite and inoculated intraperitoneally into a white mouse (RB–Ms–1), and subcutaneously into the abdomen of a guinea pig (RB–M–1). Some gland juice was obtained from one of the superior cervical lymphatic glands (left side) and injected subcutaneously into the abdomen of a white mouse (RB–Ms–2).

Smears from tissue scrapings, obtained by scraping two incisions made near the site of the bite, were also prepared January 20, 1931. The smears were stained by Giemsa's method. The spirochæte was demonstrated in them.

[5] Erythrocyte and leukocyte counts and hæmoglobin percentage determinations were kindly made by Dr. José Ramirez.

[6] Routine examination of the patient's urine was performed by Dr. G. Sepulveda, Jr.

The blood of the mice and guinea pig was examined daily by dark-field illumination. Mouse RB–Ms–2 showed spirochætes in its blood for the first time after inoculation January 30, 1931; that is, ten days after its inoculation. Mouse RB–Ms–1 became positive February 5, 1931; that is, sixteen days after it was inoculated. The spirochætes were demonstrated in the blood of the mice both by dark-field examination and in smears stained by Giemsa's method. February 5, 1931, some peritoneal fluid from the mice was obtained, using fine capillary tubes. Smears were prepared and stained by Giemsa's method. A few spirochætes were demonstrated.

February 7, 1931, the guinea pig showed palpable inguinal lymphatic glands. February 9, 1931, the glands were larger, especially on the left side. From one of these some gland juice was obtained by means of a fine capillary tube and examined both by dark field and in smears stained by Giemsa's method. No spirochætes were seen by dark-field examination, but in the stained smears several spirochætes were seen. This was twenty days after the guinea pig was inoculated.

February 10, 1931, twenty-one days after inoculation, some peritoneal fluid was obtained from the guinea pig and examined both by dark field and in smears stained by Giemsa's method.

	Microns.	Coils.
Spirochætes from blood of RB–Ms–2 [a]	2.0	3
Do	2.5	4
Do	2.5	5
Do	2.5	5
Do	2.3	6
Spirochætes from blood of RB–Ms–1	3.6	7
Do	3.8	7
Do	4.98	9
Do	3.7	7
Spirochætes from tissue scrapings of patient	2.5	4
Do	3.0	5
Do	2.5	4
Spirochætes from gland juice of guinea pig RB–M–1	3.3	6
Do	2.4	4
Do	3.3	5
Do	3.3	5
Do	2.0	3
Spirochætes from blood of guinea pig RB–M–1	3.3	7
Do	2.5	3
Do	2.5	4
Do	2.5	5

[a] Measurements of the spirochætes were kindly taken by Dr. Marcos Tubangui jointly with the author.

No spirochætes were detected by dark field, but in the stained smears spirochætes were seen. It was not until February 15, 1931—that is, twenty-six days after inoculation—that the guinea pig showed the spirochætes in its blood. They were demonstrated in smears stained by Giemsa's method.

MORPHOLOGY AND MOTILITY OF THE DEMONSTRATED SPIROCHÆTE

Under dark-field illumination the spirochæte was seen as a rather short and rigid spindle-shaped organism, which darted back and forth very quickly and as quickly disappeared by shooting to one side. The spirochætes could be seen in the clear spaces between the red blood cells. The organisms moved so fast that details of their structure could not be observed. Only occasionally, when the spirochæte came to rest, could it be seen that its body is undulated, the undulations apparently lying in one plane. In stained smears the organism was seen to be much the same as Vandyke Carter describes it (called by him *Spirillum minus*) ; namely, that it is "an extended and uniformly slender filament of clearly spiral construction, having a length commonly somewhat less than the diameter of a blood disc but varying from 5 microns to 9 microns, and according to its length presenting from four to eight close spiral turns."

CONCLUSIONS

1. A clinically typical case of rat-bite fever was accidentally encountered among cases reporting for antirabic treatment.

2. The causative agent of rat-bite fever, *Spirochæta morsus muris,* was demonstrated in tissue smears from the patient and by inoculating it into experimental animals and recovering it from them by microscopical slides, stained and dark field. The spirochæte was identified morphologically and by measurements as well as motility to be *Spirochæta morsus muris.*

3. Thus the existence in the Philippine Islands of rat-bite fever was definitely established.

ACKNOWLEDGMENTS

To Dr. Otto Schöbl, chief of the division of biology, I wish to express my appreciation for suggestions offered.

To Lt. Col. Hayashi Hirano, Medical Corps, Imperial Japanese Army, now detailed at the Bureau of Science, I am also indebted for his coöperation in demonstrating the presence of the parasite.

ILLUSTRATIONS

PLATE 1

FIG. 1. Front view of the patient's face showing the site of the bite on the forehead and the lesion that developed at the site of the bite.

2. Showing the swollen cervical glands.

PLATE 2

Side view of the patient showing œdematous feature of the lesion on the forehead and the swollen cervical glands.

PLATE 3

Smears stained by Giemsa's method. Photomicrograms taken with ocular No. 4 and 1/12 oil immersion.

FIGS. 1, 2, and 4. Showing different sizes of *Spirochæta morsus muris* and its relation to the size of the red corpuscles.

FIG. 3. Two spirochætes joined end to end.

1

2

PLATE 1.

1

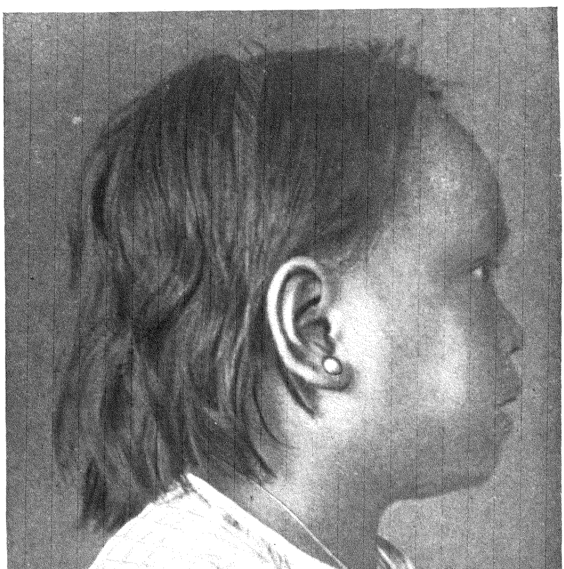

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PLATE 2.

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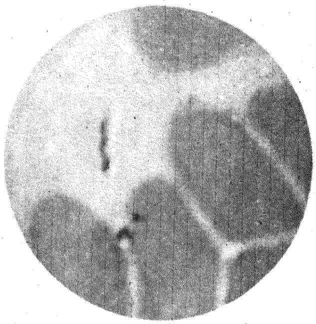

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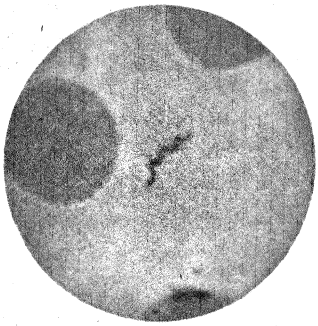

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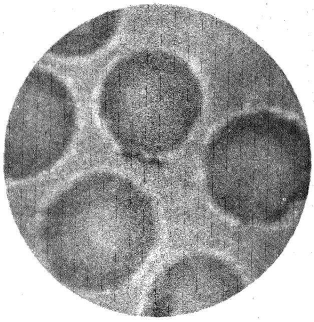

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PLATE 3.

AN INTERPRETATION OF THE LAWS OF BROWN AND PEARCE THAT GOVERN THE COURSE OF TREPONEMATOSES *

By OTTO SCHÖBL
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From the results of their classic experiments with syphilis on rabbits, Brown and Pearce deduced two laws that regulate the biologic events taking place during experimental infection and that are directly traceable in the course of natural infection in man. At least one of these laws was found by Schöbl [1] to apply to yaws as well, with a slight modification, conforming to the biologic nature of the parasite of yaws as it differs from that of the parasite of syphilis. Clinical observation showed that the law, which holds true in experimental yaws in animals, likewise applies to natural or experimental yaws infection in man. The two are known as the law of inverse proportions and the law of sequence.

The law of inverse proportions, as it applies to both syphilis and yaws, says: The more intensive the early manifestations, the less intensive are the late manifestations of the disease. This law, as expressed above, applies as much to syphilis as it does to yaws. In syphilis, however, it enters into play in the relation between the primary and the secondary stage, as well as between the secondary and the late manifestations; while in yaws it is true only between the early stage on the one hand, and the late manifestations on the other.

The second law of Brown and Pearce is the law of sequence. The various systems of tissues are affected successively. This law is clearly evident in human syphilis where the integument, the internal organs, the cardiovascular system, and the central nervous system are affected successively and in combinations with great regularity. In yaws this law has little application due to the epidermotropic tissue selectivity of the parasite that

* Received for publication February 5, 1931.

[1] Philip. Journ. Sci. 35 (1928) 211.

causes this disease. While early yaws lesions are restricted to the skin exclusively, the late ulcerative lesions also occur in the skin but may by continuity migrate into the tissues immediately attached to the integument. Thus subsequent to an ulcerative skin lesion the muscle, the periost or cartilage, and even the bone may be affected by an hypertrophic, atrophic, or ulcerative process originating in the skin. By the time the lesion is seen in the clinic the original skin lesion may have healed by scars while the lesion in the bone, for instance, may persist at the time when the patient is first seen. It is nothing but a part of the original skin lesion that migrated, healing as it traveled. The entire course of development of such lesions is never seen in the clinic. The clinician has entered the theater in the third or last act of the drama. Unless these lesions are experimentally produced and followed step by step, the pathogenesis of late yaws lesions remains an unsolved mystery to the clinician, who is surrounded on a yaws clinic by a veritable kaleidoscope of chronic clinical phenomena, the past and the future of which may never come within the range of his vision.

The present author is unaware of an adequate interpretation, or any at all, of the laws as first formulated by Brown and Pearce. In the course of experimental work on yaws and syphilis, performed partly on human volunteers and partly on suitable animals, which the present author has carried on in the course of the last seven years, certain findings were made that correlated themselves, as the work progressed, into a logical chain of what appeared to be natural causes of the nosologic phenomena that form the clinical course of treponematoses and for which laws were deduced by Brown and Pearce.

The first observation in this direction was made when it was found that the intensity of early yaws lesions stands in direct proportion to the number of treponemas contained therein.[2] Since the intensity of the early lesions stands in inverse proportion to the intensity of the late lesions, in yaws as well as in syphilis, the law could be expressed thus: The relative number of invading parasites in the early stage of infection stands in inverse proportion to the intensity of the late manifestations.

The second finding was that the serologic response due to superinfection stands in inverse proportion to the serologic response of the original infection.[3] The law of inverse propor-

[2] Philip. Journ. Sci. 35 (1928) 257.

[3] Op. cit. 272.

tions was found reflected in the serologic picture of experimental yaws and syphilis.

The next link in the chain of experimental results was the finding that a time relation exists between the late serologic response and immunity.[4] At the time the late response becomes apparent in the form of strong serologic reactions the resistance to superinoculation is fully developed, and any experimental procedure that accelerates the late serologic response hastens the development of resistance to superinoculation or reinfection. From our early experiments with yaws it is known that no new lesions form, either secondary or late ulcerative ones, from the time the yaws monkeys become immune to superinoculation; but the respective generalized or late ulcerative lesions that have developed before that time persist. We formulated this finding in the statement: The time during which the secondary or the late ulcerative yaws lesions form is limited by the development of immunity and is shorter than the time necessary for the healing of the already existing lesions. Prior to the onset of such a high degree of immunity that it completely prevents the formation of specific lesions at the place of superinfection, metastatic lesions develop that are atypical and have been called by us frambœsides. Late ulcerative lesions may form at the place of superinfection at this time.[5] Both types of lesions contain such a small number of treponemas that it is difficult and frequently impossible to demonstrate their presence in the lesions by dark-field microscope. These lesions occur after the typical ones and before complete resistance sets in. From these experimental findings we have deduced the explanation that partial immunity is responsible for the modification of the morphology of treponematous lesions.

The law of inverse proportions, which is the first law of Brown and Pearce, can be expressed as follows: The number of the invading treponemas during the early stage stands in direct proportion to the degree of immunity that subsequently develops. It stands in inverse proportion to the time necessary for the development of immunity, or in other words, the number of invading parasites in the early stage of infection stands in direct proportion to the speed with which immunity develops, the speed being the ratio between quantity and time. This law of direct proportions between the number of invading parasites

[4] Philip. Journ. Sci. 42 (1930) 203; 43 (1930) 603.

[5] Philip. Journ. Sci. 35 (1928) 230–236; 242–251.

and the speed of development of consequent immunity applies not only to the living parasites but also to the lifeless antigen, to the infection and the following vaccination or vice versa. Thus the law has a general application and can be finally formulated as follows: The degree of subsequent immunity and the speed of the development of immunity stands in direct proportion to the amount of treponematous antigen. Due to this direct proportion between the treponematous antigen and the subsequent immunity, the immunity stands in indirect proportion to the duration of the clinically active disease.

The law of sequence indicates successive involvement of various tissue-systems by the syphilitic infection. The treponemas invade the blood stream from the initial portal of infection in its early stage. This is true of syphilis as well as of yaws. In the case of yaws, contrary to syphilis, the parasites do not colonize the internal organs permanently and do not produce lesions in these organs. In the case of syphilis, the parasites remain viable in the mesoderm for a very long time, if not for life.

The treponemas being disseminated into the various tissues through the blood stream in the very early stage from the portal of infection, the law of sequence is not based on a successive invasion of the various tissues by the parasites. The integument comes in contact with the treponemas first of all. They invade the internal organs in the early stage of infection, but the heaviest immigration into these organs takes place when the treponemas are present in the largest numbers in the initial lesion; that is, at the time when the initial lesion is fully developed. Thus the tissues of the integument, which form the seat of the initial lesion, in a typical clinical case of syphilis pass from the stage of sensitization through the negative phase into the positive phase somewhat ahead of the other tissues. The immunity is transferred from one to the other systems of tissues; first in the form of a delayed incubation period, then in the form of a changed clinical and anatomical morphology of the lesions. It is very likely true of all infections, but in treponematoses, and particularly in syphilis, it is clinically evident that before immunity becomes fast a more or less pronounced oscillation between the negative and positive phase of immunity takes place. This swinging of the pendulum between the positive and the negative phase is not necessarily synchronic in all tissues, because even in normal skin the incubation period of two or more experimental lesions produced

by simultaneous inoculation of the same amount of the same yaws-inoculum, by the same method, and under the same tissue conditions, even in symmetric parts of the same animal, is not always the same. Thus the fate of a focus of treponemas deposited in a given tissue, in the course of treponematous infection, is influenced by the phase of the transmitted immunity due to the activity of another focus of treponemas deposited in another place of the same or in another system of tissues. An almost healed yaws lesion was brought to an extensive exacerbation, and dormant deposits of yaws treponemas were incited to formation of lesions, after an extraordinarily long incubation, by superinoculation with syphilis that failed to produce syphilitic lesion. On the other hand superinoculation of yaws monkeys with syphilis that produced syphilitic lesion resulted not in exacerbation of the existing yaws lesion but in a striking acceleration of yaws-immunity.[6] This shows that immunity in its negative as well as in its positive phase is transmitted between tissues.

An immunity that is on an upgrade incline may be accelerated into the positive phase, while the immunity in another part of the same system of tissues or in different systems of tissues that is on the downward incline may be accelerated into a deeper negative phase by superinfection than would be otherwise possible. It is clearly evident that spontaneous exacerbation of a lesion takes the place of an experimental superinfection in this respect. One is a superinfection from within, the other from without. The decisive factor is the sudden increase of treponematous antigen, dead or alive, that is brought in contact with mesodermic tissues in these instances. The variation of the incubation period, which is made much more elastic by the initial immunity, makes incalculable the possible effects of the intermingling immunity-phases on the course of the main immunity curve, which in itself is not steady. They can, however, be predicted in a general way.

The second law in syphilis of Brown and Pearce, that is, the law of sequence, is here interpreted as a sequence of immunity that develops successively in the various systems of tissues. The treponemas that invade the various tissues, long before the immunity has developed, can multiply and produce lesions only in those tissues that are not yet immune. Not all tissues are equally capable of producing immunity in treponematoses. This

[6] Philip. Journ. Sci. 42 (1930) 239.

is evident from the findings that treponema pertenue introduced into the epiderm causes immunity to develop in six months; when introduced into the mesoderm in six to eight weeks.[7]

The explanation given here, that is, the successive transmission of immunity from tissue to tissue, explains the well-known clinical observation that specific syphilitic lesions develop in the internal organs or in the central nervous system in a host whose integument has long become immune to reinfection and to relapses. A better explanation of the condition known as neurosyphilis is to assume that due to insufficient immunization in the early stage of the infection, which may have been caused by mild early lesions, by insufficient sterilization of the host, by treatment given in the early stage of the disease, or by superinfection, taking place in a partially immune body, it may have assumed the symptomless form, rather than the explanation given at times in the literature that, due to the modern arsenical treatment, the syphilitic infection becomes neurotrophic. Strains of treponema pallidum isolated from neurosyphilis produce typical chancres in experimental animals and otherwise behave like any other strain isolated from a primary lesion. They do not show any signs of permanent changes in their biology and behave differently in the body of the neurosyphilitic case, from which they were isolated, on account of the changed condition of that particular patient's tissues and not on account of a change in the biology of the parasites. A simple experiment convinced us of the truth of our supposition that immunity in syphilis involves the various tissues at different stages and in succession. A series of yaws monkeys inoculated with yaws more than a year prior to this experiment, and that repeatedly had been proven immune to yaws were inoculated with Nichols strain of syphilis on one side of the scrotum *intradermally*. No lesion developed at the place of inoculation but the normal control animal developed a typical sclerosis. In due time the corresponding inguinal glands were excised and transferred to rabbits' testicles. None of the rabbits that received the glands from the immune monkeys developed lesions and they were found susceptible to syphilis five months later. Thus it was proven that the lymph glands contained no treponemas. The rabbits that received the lymph glands from the nonimmune controls developed typical chancres. Thus it was proven that the inoculum contained viable virus of syphilis. Two months

[7] Philip. Journ. Sci. 35 (1928) 280; 45 (1931) 221.

later the immune monkeys were reinoculated with syphilis by *intratesticular* injection on the opposite side from the point where the first inoculation with syphilis was introduced. The lymph glands, corresponding to the place of the second, the *intratesticular* inoculation, were transplanted to rabbits. One half of the rabbits developed chancres and the other half remained normal. The latter animals were found susceptible to syphilis five months later. This experiment shows that all of the animals immune to yaws were also immune to syphilis as far as *skin* was concerned, but only some were immune to syphilis with regard to *internal organs* at that time. Two months after the *skin* immunity was established the *internal organs* concerned were immune only in some of the experimental animals and not in others.

SUMMARY

The law of inverse proportions of Brown and Pearce is interpreted as a direct proportion between the quantity of treponematous antigen, dead or alive, and the degree of immunity and the speed of its development. The law of sequence of Brown and Pearce is interpreted as a successive development of immunity in the various systems of the body's tissues.

This interpretation, based on experimental facts, brings these laws in agreement with the laws that govern antibacterial immunity, and is a contribution to the knowledge of tissue immunity.

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COEXISTENT INFECTION WITH YAWS AND SYPHILIS

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Clinical observations made on man and experimental experience with humans and animals, show that yaws infection can supersede that with syphilis and vice versa. This phenomenon has been interpreted in various ways in the past. Those authors who maintained that yaws and syphilis are distinct and different diseases used these observations as proof of their dualistic interpretation of the treponematoses, while the opposite side claimed that lesions were found in yaws patients that could not be distinguished clinically from syphilitic lesions and deduced that yaws and syphilis are one disease.

The new designations that are given by the unitarians to yaws such as "tropical syphilis," "primitive syphilis," and "rural syphilis," to distinguish yaws from "civilized syphilis," or "city syphilis," prove ipso facto that all is not well with the unitarian theory or else such differentiation in designations would not be necessary. It appears from the literature that the possibility of coexistence of the two diseases in one and the same patient, and particularly the influence that coexistent infection with syphilis may have on the clinical course and manifestations of yaws or vice versa, have not been considered.

Unfortunately, the question of the relation between yaws and syphilis is a far deeper problem than merely one of clinical nomenclature. It is a question of different organotropism of the treponema of yaws from that of the treponema of syphilis. It is not an isolated phenomenon and finds its analogy in certain relations of leprosy to tuberculosis, of herpes to encephalitis, and probably of dengue to yellow fever. The question of organotropism with regard to infection and immunity very likely has more general application than is suspected today, and the once inviolable laws of specificity of infection and immunity are being modified constantly, as is also our conception of immunity.

The experimental evidence that has come to light through our researches,[1] which shows that reciprocal immunity exists between yaws and syphilis, does not prove that the two diseases are one and the same, as it appears to at first sight. On the contrary, the difference in immunologic conditions existing in yaws and in syphilis, both in animals and humans, as well as the difference in the behavior of the two infections with regard to cross immunity, shows plainly that fundamental immunologic differences exist between yaws and syphilis. These differences, like those of the tissue selectivity of the respective parasites, the pathology, pathogenesis, clinical course, transmission, geographic and age distribution, stand in complete agreement with the fundamental biologic distinction between the parasite that causes yaws and the parasite that causes syphilis.

Experimental evidence shows that infection with syphilis may have a decided effect on the course of a coexisting yaws infection. This effect is evident in two directions. According to the stage of immunity that is present at the time when the syphilitic lesion develops in a yaws-infected host the immunity may swing into a negative phase and exacerbations or relapses of the basic infection may occur.[2] On the other hand, the immunity may swing rapidly into the positive phase[3] and the effect of such cross superinfection will be beneficial to the host, inasmuch as the rapidly accelerated immunity prevents the development of further stages of both yaws and syphilis.

Therefore, it is quite evident that syphilitic lesions, as well as yaws lesions, may coexist in one and the same host just as leprous lesions and tuberculous lesions may coexist in the same patient. This coexistence certainly does not justify the conclusion that syphilis and yaws are one and the same disease. If lesions that cannot be differentiated anatomically from syphilitic lesions are found in internal organs of yaws patients, such as the cardiovascular system or the placenta, there is every reason to assume that these lesions are of syphilitic rather than of frambœsic origin, and the possibility of a double infection must be considered in such cases. There is hardly a corner of the world where syphilis has not been introduced. A statement made in German literature that Nichols strain of yaws, after repeated passages through rabbits over a period of two years,

[1] Philip. Journ. Sci. 42 (1930) 203, 239; 43 (1930) 263, 429, 583; 45 (1931) 221.

[2] Philip. Journ. Sci. 42 (1930) 245.

[3] Op. cit. 241.

changed its character suddenly so as to become indistinguishable from that of syphilis, merely shows, provided that no error was committed since both Nichols strain of yaws and Nichols strain of syphilis have been imported to Germany, that the experimental animal used, the rabbit, is unsuitable for the study of yaws. The subject to be studied, yaws, became unrecognizable in this kind of animal. Retroinoculation to men or to a Philippine monkey would be the only procedure in such a case.

The frequent and unduly exaggerated statements that yaws lesions cannot be differentiated from syphilitic lesions clearly prove that mere clinical inspection, unsupported by other methods and procedures of biologic investigation, has its limitations, which must naturally vary with the dermatologic training and experience of the observer.

The crucial test that decides whether a given doubtful lesion is of frambœsic etiology is the inoculation of the material obtained from this lesion to a suitable experimental animal. Thus, an atypical yaws lesion in a patient, with which the diagnostician may not be acquainted, is reduced to a typical initial lesion of yaws in a suitable animal and may be easily recognized even by a less trained or less experienced physician. Due to the great morphologic similarity of *Treponema pertenue* and *Treponema pallidum* the mere microscopic demonstration of treponemas in smears or sections cannot settle whether a given lesion is of frambœsic or syphilitic origin. By inoculation of the material from atypical yaws lesions to monkeys, we were able, on several occasions, to confirm our clinical diagnosis of yaws and to convince the attending physician that the lesion was yaws and not syphilis.

It must be borne in mind that the treponematoses are chronic infections, that the immunity develops slowly, that there is a great number of possibilities in the scale of immunity from complete susceptibility to complete immunity, and that the quantity of early infection affects the progress of the immunity in direct proportion as to degree and in inverse proportion as to time.

The possibilities are further augmented by the mutual interference of cross immunity between yaws and syphilis. The degree of immunity at a given time in the course of a treponematous infection has a deciding effect on the modification of subsequent clinical lesions. Not only the homologous but also the cross immunity between yaws and syphilis modifies mutually the clinical character of the lesions and the course of the dis-

eases. This modification varies according to the degree of immunity existing at a given time. A treponematous lesion develops when the parasites propagate at a given site in the host's body tissues. Immunity of low grade restricts the propagation of treponemas lodged in the tissues and a modified or atypical lesion may develop. The highest grade of immunity suppresses completely the propagation of the parasites in the tissues and no lesion develops. This is true of homologous as well as of cross immunity between yaws and syphilis. When a host infected with yaws develops no lesion at all at the place of homologous superinoculation, the infection is brought to a standstill and no new yaws lesions will develop. The host has reached a high degree of homologous immunity. At that time, however, he has not yet become immune to cross infection, and if originally infected with syphilis, for instance, may contract yaws, with either a typical or modified course, for some time after the superinfection with syphilis no longer produces a lesion. From this it follows that simultaneous or subsequent cross infection with yaws and syphilis is to be considered as a probability in a clinical case. A cross infection is possible beyond the time when a high degree of homologous immunity has developed and up to the time when a group immunity develops, which then includes not only homologous but also heterologous treponematous infection as well. The condition of tissue nonreactivity that develops in syphilis after the infection has lasted for some time is frequently referred to as anergy. This term, however, is misleading as to the nature of this tissue condition, insinuating, as it does, a property of tissues that has been lost rather than a property that has been gained. Animals infected with syphilis in our experiments soon reached a stage in which a subsequent homologous superinfection no longer produced a lesion. The absence of lesion at the place of superinfection is due to the inability of the parasites to multiply and the non-development of the lesion is due to this factor and not to the inability of the tissues to react. The parasites do not multiply under these conditions and consequently do not exert sufficient irritation to cause the tissues to react. When the very same syphilitic animals that failed to develop lesion as a consequence of superinfection with syphilis were superinfected with yaws, the tissues reacted promptly and a yaws lesion developed, showing that the tissues were capable of reacting to the introduction of parasites for a considerable time after they no longer reacted to the homologous superinfection and before

the cross immunity to yaws developed in syphilitic animals. There seems to be no reason why this phenomenon of so-called anergy should not be interpreted as immunity, which suppresses the propagation of the parasites either completely or at least partially.

The clinical result of cross infection with yaws and syphilis may be either an exacerbation of the basic, as well as of the subsequent infection, or the subsequent cross infection may bring about a partial or complete suppression of both coexisting syphilis and yaws, in which case further stages of both diseases will be limited or completely suppressed. Which of the two possibilities will happen depends on the degree of immunity present at a given stage of the disease.

THE PROSPECTS OF VACCINATION AND VACCINE THERAPY IN TREPONEMATOSES *

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The clinical course and the ultimate result of treponematous infections, like those of any other infection, are determined by the biology of the parasite and by the immunity that develops in the course of the infection. Whether the innate nature of a parasite is to multiply consecutively or intermittently, that is in a cycle, the parasites should propagate progressively in the body of the host and the inevitable consequence thereof should be the death of the host. This, however, is not always the case even in the most acute infections and it rarely occurs in such chronic ones as the Treponematoses. The chain of subsequent biologic events that take place in the course of treponematous infections, which are the result of mutual interaction between the parasite and the tissue response of the host, may be spoken of as immunity in "statu nascendi." The ultimate immunity prevents the parasites that have invaded the tissue of the host, previous to or subsequent to the full development of immunity, from further propagation. No new lesions develop from that time on. Definite and well-known laws govern the clinical course of treponematoses from the beginning of the infection to the end. These laws are determined by a quantitative relation between the parasites and immunity. There exists a direct quantitative proportion between the number of parasites present in the body of the host and the degree of subsequent immunity, and an inverse proportion between the number of parasites and the time necessary for the development of immunity. The more parasites there are present in the early stage of the infection, the higher the degree of immunity that will develop, and the quicker it will set in. The clinical course of the infection in treponematoses and its consequences are determined in

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the early stage of the disease by the relative number of parasites. The earlier the immunity develops, the shorter and less tragic is the course of the disease. Further progress of the disease is halted in any stage of the disease whenever full immunity sets in. The immunity in treponematoses can be accelerated by artificial means, and the course of the disease can be influenced thereby. A high degree of immunity can be made to set in before the expiration of the incubation period of the primary, or of the generalized so-called secondary manifestations or of the late forms.

The experimental evidence on which these statements are based has been published, likewise the possibility of preventive vaccination and vaccine therapy in treponematoses has been demonstrated on animals. It is the object of this communication to discuss the mechanism of these vaccination procedures in order that an appraisal of the practical possibilities may be realized.

The intimate relation between the serologic response of the infected body organism and the stages of immunity in statu nascendi in the course of treponematous infections is unquestionable. Coincidently with the development in animals of the primary lesion, which is the clinically visible sign of sensitization, and provided that only local lesion develops in the course of the infection, the curve that registers the results of serologic examinations rises to a more or less high point, the strength of the serum-reactions being directly proportional to the intensity of the lesion, in other words to the number of parasites present in the primary lesion. With the healing of the primary lesion, the serologic curve returns to normal, only to rise again to the highest point at the time when a high degree of immunity sets in.

In animals immunized with lifeless treponematous antigen, only the early serologic response becomes evident, that is, the one which is coincident with the primary lesion in case of infection. The late response is absent in case of vaccination with killed treponemas, or it is possible that it is very much delayed.

If generalized manifestations appear, following the development of the initial local lesion, the late serologic response as well as the development of immunity is accelerated. An analogous phenomenon occurs if infection takes place following vaccination with killed treponemas, that is, a sudden rise of the serologic

curves and acceleration of the development of immunity. We may express it in the following way. From the serologic and immunologic standpoint, the preventive vaccination takes the place of the primary lesion, and the infection that follows the preventive vaccination takes the place of the generalization of the treponematous infection, the so-called secondaries. Clinically speaking, there are several possibilities when treponematous infection invades the vaccinated body organism. The result depends on the time relation between the incubation time of the infection and the speed of the acceleration of immunity as a consequence of the infection itself. If the time necessary for the accelerated immunity to reach a high degree is shorter than the incubation of the infection in the vaccinated body organism, then no lesion develops. If the time required by the immunity to be accelerated to a high degree by the subsequent infection is longer than the time of incubation, a local primary lesion develops, but the immunity is raised thereby, to a high grade, before the time when the generalized manifestations (the secondaries) or the late forms (the tertiaries) can occur. Consequently, following the primary lesion, no subsequent stages of the disease develop.

Specific antitreponematous treatment, when administered in the early stage of a primary lesion, delays the onset of immunity far beyond the time at which immunity sets in if infection is allowed to run its course without treatment. Under these circumstances treponematous reinfection or relapses, if the treatment was not complete, are possible for a long time. Vaccine therapy, administered after early specific cure, accelerates the immunity. Within a short time after the vaccine therapy has been administered a reinfection is no longer possible. The primary lesion is accompanied by a rise in the serologic curve, which drops to zero following the treatment. The development of immunity is delayed by early treatment, and the earlier the treatment is administered the more is the immunity delayed. In other words, a primary lesion whose progress has been terminated by early specific treatment has the same serologic and immunologic effect that vaccination with killed treponemas has in healthy animals. Intramesodermal incorporation of antigen, living or dead, causes a rapid development of immunity. Thus reinfection after early cure may be prevented by vaccine

therapy, or in case that primary lesion develops due to reinfection no further stages of the disease will develop.

Vaccine therapy administered to an infected host without previous or simultaneous specific antitreponematous treatment provokes a negative phase and severe lesions may appear in such a case.

The most opportune time for an effective application of antitreponematous vaccination, either before natural infection has taken place or after the body organism has been infected, is the stage of normal or the stage of exaggerated tissue reactivity. When the tissues reach the stage of diminished reactivity the effect of the antigen supplied by vaccination will be slight or nil. The immunity in treponematoses runs the general course of a saturation curve. It follows inevitably from the shape of such a curve that its rise can be influenced effectively in the initial phase, somewhat in the middle phase, and very little, if at all, in the last phase of the curve. In order to be effective the vaccination with killed treponemas must take the place of a vigorous infection of the early stage so that, according to the law of inverse proportions of Brown and Pearce, the subsequent stages of the disease are very mild or do not manifest themselves at all. Whether administered to a healthy body or to a previously infected host the antitreponematous vaccination is a preventive measure and tends to hasten an immunity that, in turn, prevents the development of subsequent stages of the disease. It has no apparent healing effect on the lesions that have already developed. The vaccination with killed treponemas is a controllable and harmless substitute of a severe early treponematous infection that, as experimental evidence and clinical observation show, prevents the development of late stages of the disease.

These statements with regard to vaccination and vaccine therapy are based on experimental evidence and refer to experimental animals.

A fair estimate can be made of the possibilities of vaccination and vaccine therapy in treponematous infections in man. This estimate has not been made by merely applying the experimental findings made in monkeys to man, but by drawing a comparison between the conditions experimentally found in monkeys and the conditions that were found in experimentally inoculated humans. No rational objection can be held against such comparison, particularly in the case of yaws, since it has been proven that by appropriate experimental procedure an infection can be produced in monkeys that runs the same course and manifests

itself in these animals in the same principal forms as does the disease in human beings.

The incubation period of the primary yaws lesion, and of the generalized so-called secondary stage in monkeys, is the same as was experimentally found in humans. In monkeys the immunity sets in earlier than it was found to take place in experimentally infected human volunteers. This finding explains the fact that the period during which generalized and late yaws lesions crop out in monkeys is shorter than in man. From this comparison, it is safe to predict that the effect of vaccination in human treponematoses will not be as prompt as in experimental animals. The degree of immunity, however, in these infections, as well as the rapidity of its development, depends on the amount of vaccination and on the proper time at which immunization is carried out. Furthermore, experimental inoculation is a far more severe test for immunity than the one that is usual in the great majority of natural infections of man. We may, therefore, rightfully hope that this procedure will be a valuable addition to our present armament for combating human treponematoses, that is yaws and syphilis.

DECAY OF WOOD IN AUTOMOBILES IN THE TROPICS

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TWO PLATES

The depreciation of automobiles in the Tropics from decay of the wood used in their construction reaches a staggering figure in proportion to the investment. The various kinds of timber used in their manufacture are not, as a rule, adapted to withstand the warm humid weather to which the cars are constantly subjected. As a result of this the timber replacement business, in the City of Manila alone, has become a considerable industry.

Most of the cars in the Philippines are of American manufacture; a few come from Europe. The woods used are almost exclusively native temperate-zone species selected for their strength, toughness, workability, etc., rather than for their durability. In American cars [1] ash, beech, birch, elm, hickory, maple, oak, and sycamore are commonly employed in places requiring strength. Hickory is regularly used for spokes and rims; oak for top bows. For running boards, seat risers, seat lids and other parts not requiring strength, chestnut, gum, tupelo, yellow pines, Douglas fir, etc., are commonly employed. With the exception of white oak, chestnut, resinous yellow pine, and heart red gum these are all recognized as being only moderately resistant to decay. When sapwood is used it is very perishable regardless of the durability of the heart.

The automobile and truck business in the Tropics has reached a considerable volume, the registration [2] for 1929 in the Philippine Islands being 21,341 passenger cars and 10,365 trucks, of which 9,545 cars and 2,965 trucks were registered for the City of Manila. The turn-over of used cars is comparatively large, this being to an appreciable extent occasioned by the rapid deterioration of the wooden parts. Many people prefer to dispose of a car that has seen service of one or two years rather than

[1] Information published by Mr. Luis J. Reyes in the special forestry edition of the Manila Daily Bulletin, summer of 1928.

[2] Data furnished by the Bureau of Public Works, Manila.

submit to the inconvenience and expense of dismantling the body for the purpose of replacing the timber. It is at best a gamble as to the extent of renewals necessary, for a proper estimate of cost can only be reached by fully exposing all the wood. Estimates made on any other basis are usually high, in order to take care of the probable deterioration of unseen parts. The writer has rebuilt the bodies of two cars and in both cases practically all of the wood needed replacement.

Often the deterioration becomes distinctly noticeable within the first year's service, and there are many instances where extensive repairs have been necessary at the end of two years, or even within one year. For cars in service longer than two years it is safe to assume that decay is at least well started at some important point (Plates 1 and 2). It impresses itself upon the attention when the sills and vertical members have become sufficiently decayed to permit the doors to sag and be thrown out of alignment. Top members upon which any weight is hung, such as the wind shield, also begin to rattle or give way entirely. The decay may also spread to the upholstering or even affect the top covering.

Repair work in the Philippines is not very thorough, as a rule, partly as a result of the desire to keep the cost down, partly through ignorance as to how wood decay develops and spreads. Another factor in the situation is the trading in and resale of used cars after conditioning them at the least possible expense. A splice here and there, a few bolts tightened, a new coat of paint, a new bit of upholstery, and perhaps a new top covering, work wonders in appearance and often hide from the unwary the more serious defects within. Even in what are considered bona fide jobs the contractor often uses poor judgment in failing to take out timber showing early stages of infection, little realizing that all traces of the wood-decaying organism must be eradicated if the further spread of the decay is to be stopped. It is often false economy to splice, and if the top framing or the sills show considerable decay at the joints or elsewhere the better procedure is complete replacement. This opinion is based on the assumption that if the timber is so perishable as to rot out at any point within a short period it will continue to do so, the probabilities being that the replacements will out-last the original timber left in and necessitate further repairs within a short time.

WHAT CAUSES DECAY

Decay is conditioned upon moisture. Free water must gain access to the wood in some manner. This may occur indirectly by condensation when a cool surface is in contact with a saturated atmosphere, or directly, through a leak in the top or elsewhere, or when beating tropical rains force in moisture around the closed doors and windows. Much wetting of the sills also occurs through negligence in leaving doors or windows open during storms, and some of it occurs during the process of frequent washing.

Wet wood in a car dries but slowly, for it is usually covered. When water reaches a joint it penetrates deeply and gets well into the interior of the timber at the joined ends. This end penetration of moisture into wood is very rapid and easily demonstrated. It is thus a simple matter for water to enter at the joints but very difficult for it to get out, even in rather dry weather. When one stops to consider, however, that during a tropical rainy season over 100 inches of rain may fall and weeks may pass with the air at or near saturation, it is small wonder that cars built of perishable wood deteriorate rapidly. Six months under test conditions very highly favorable for decay will destroy for practical use nearly all the temperate-zone woods now used in American or European-made cars.

The next question that arises is what agent causes this deterioration. It is all due to the presence of fungi belonging to the more highly organized groups, principally the Hymenomycetes. These fungi are plants fundamentally differing from ordinary plants only in the lack of green coloring matter and the method of nutrition. Ordinary plants must get their food from the soil and air, therefore, they must have the green coloring matter to act as a catalyst in the manufacture of carbohydrates needed for growth. Fungi get all their food from the organic substances upon which they grow, therefore, there is no need for chlorophyll. They must, however, produce ferments to render soluble and assimilable the various chemical substances of which their substratum is composed. Wood-destroying fungi are abundantly supplied with the ferments necessary to decompose the compounds in wood, of which the principal ones are cellulose and lignin, with some sugars and starches.

Wood-destroying fungi require for growth a small quantity, of air, a favorable temperature, suitable kinds of wood, which

do not contain substances poisonous to, or inimical to, the growth of the organisms, and a considerable amount of moisture. The first and second requirements are met at all times in the Tropics, where the temperature rarely goes below 60° F. and most of the time is around 80°, or somewhat above. The third condition is met when perishable woods such as are ordinarily employed in automobile construction are used, and this is particularly true of the sapwood of practically every species of tree known. The third condition is readily met in the Tropics, where high humidities and heavy rainfall prevail, and is accelerated by the factors mentioned in the third preceding paragraph. While scientific knowledge of the exact amount of moisture most favorable to decay is lacking, enough data have accumulated to indicate that the amount will vary for the kind of wood under discussion. It is quite safe to say that ordinary absorption of moisture from a saturated atmosphere (fiber saturation point) is not sufficient for decay and that a certain amount of free water must be present in the cavities of the wood cells or fibers for the fungus to grow vigorously and break down the structure rapidly.

LIFE CYCLE OF WOOD-DESTROYING FUNGI

The life cycle of wood-rotting fungi is quite simple. Each fungus has two principal stages of growth, the sporophores, or fruiting bodies, which take the place of the seed-bearing apparatus of green plants, and the mycelium, which functions within the wood as an absorbing system comparable to roots. The mycelium is the stage that causes the damage. It consists of fine cottonlike branched threads, which ramify throughout the wood tissues and by the secretion of various ferments cause their disintegration. These threads develop abundantly in any closed-in moist space and may thus spread rapidly over the surface of such inclosed timbers (Plate 2, figs. 7 and 9), as well as within them.

After the wood becomes partially decayed the fungus attempts to form fruiting bodies on the surface. These are very often abortive and may consist only of cushions of compact mycelium when developing in the dark, but when they have access to light they take on a more or less definite form by means of which they can be identified. Such fructifications developing in the light soon become fertile; that is, the outer surface of such types as grow in a thin layer flat against the wood, or the under surface of shelving forms, produce large quantities of spores that are

comparable to seeds. These spores are very minute and easily disseminated by air currents. When they lodge on the surface or in the joints of moist wood, or even on wet cloth fabric, they readily germinate to produce another crop or mycelial threads, which in turn quickly penetrate and rot the material. In this way organic construction materials are constantly subject to infection, and when conditions are right for germination and growth of the fungi, and the wood is not resistant to attack, disaster comes.

Up to the present time only three species of fungi have been observed fruiting on automobile wood; namely, *Lenzites striata* (Plate 2, fig. 10), *Polyporus sanguineus*, and *Trametes versatilis*, but there are, in all probability, a number of others that have not been found in fruiting condition. These species are inhabitants of warm regions and are well represented in the Philippines as well as in the southern United States. They are all species that are resistant to drying, to rather high temperature, and to bright sunlight, as is evidenced by their frequent occurrence on timber in the open, rather than in the shady, cool, moist forest. There are a number of other such resistant species that one would expect to find attacking automobile bodies, exposed as they are to such fluctuating climatic conditions.

It appears probable that the infection of the wood occurs after the cars reach the Tropics. This would certainly be the case if all the wood going into their construction were kiln dried before use, for the usual processes of artificial drying sterilize timber quite effectively.

PREVENTION OF DECAY

On this assumption then, what can be done by the manufacturer to adapt his product to tropical conditions? There appear to be but two alternatives; either he must select the heartwood of reputedly durable species of timber, or else the nondurable woods now in use must be treated with a preservative.

It is said that durable tropical woods are being used in certain European-made cars and that these are giving very good service in the Tropics. American manufacturers may use a few exotic woods for trim, but their inclusion as principal members has never come to the attention of the writer. There are a great number of Philippine woods that are well adapted to automobile construction and that combine high resistance to decay with the other mechanical properties desired. The difference in cost of these superior tropical woods is a very small item in the total

cost of manufacture and could readily be absorbed through the increased business incident to the production of a car that would stand up under severe conditions for a reasonable length of time. It is absurd for a manufacturer to spend millions on improved mechanical development and then house it all in a rotten shell.

Whether it would prove more economical to import these tropical woods into the States for use in cars destined for the Tropics or to thoroughly impregnate the nondurable American woods now in current use is a matter for the manufacturer to decide after checking up the respective costs. Either procedure would be satisfactory from a durability standpoint. It is safe to say that wood-frame cars in the Philippines are now at a serious disadvantage and are becoming increasingly unpopular. Steel is giving good service and discriminating buyers are turning more and more to it from the standpoint of both service and safety.

METHODS OF APPLYING WOOD PRESERVATIVES

The American manufacturer who wishes to use wood preservatives has at his call a well-developed industry using standard and proven processes, but if he should wish to treat his own stock a suitable small pressure plant could be installed at a very moderate cost.[3] At present a small amount of treated timber is being used in American-made cars, but it is insignificant and not at all commensurate to the needs. It is unnecessary to go into the details of treating methods other than to state that pressure treatments are indicated. The principal commercial substances injected into wood to increase its durability are coal-tar creosote, zinc chloride, and sodium fluoride.

Creosote is the best all-around preservative known and is particularly suitable for sills or timbers closed in by metal or other impervious covering, for it is a brown to blackish oily substance that would readily stain fabric. For other places a colorless water-soluble substance like zinc chloride or sodium flouride is preferable, the former being used in a 6 per cent concentration, the latter in a 3 per cent. Wood treated with either of the latter substances can be satisfactorily painted if necessary.

[3] Full information can be secured from the Forest Products Laboratory, Madison, Wisconsin, or from the American Wood Preservers' Association, Chicago, Illinois.

It is also claimed[4] that creosoted wood can be satisfactorily painted. The article cited states that "results thus far obtained indicate that the use of aluminum paint on creosoted wood is entirely satisfactory, providing the proper vehicle is used and the wood is first allowed to dry for a time after treatment." If this be the case the sole objection to the use of creosote on exposed parts of the automobile body would be overcome.

In replacement work preservatives could also be used to advantage in the Tropics. Most shops in Manila use untreated guijo (*Shorea guiso*) for general repair work. This is a moderately heavy to heavy wood, which is rather hard, tough, and difficult to split. It is moderately durable and is widely used in the Philippines for vehicle parts. Unfortunately, this wood is refractory to preservative treatment. Apitong (*Dipterocarpus* spp., officially *D. grandiflorus* Blco.) is another Philippine wood, however, that compares well in strength with American white oak and that readily absorbs either creosote or water-soluble preservatives, hence is widely used for treated ties, poles, posts, piling, etc. There is no reason why it cannot satisfactorily be used in place of guijo, with the added advantage, when properly treated, of being highly resistant to decay. There should be no necessity for replacing treated apitong during the life of the car. A proper treatment would be about 6 pounds of creosote per cubic foot (empty cell pressure process), or approximately 0.5 pound (dry salt) of zinc chloride or 0.25 pound of sodium fluoride.

As an alternative to this more-approved procedure, soaking the timber, after framing, for several hours in a wood or iron vat of the hot solution and then allowing it to cool in the same solution to atmospheric temperature would also give a high degree of protection, probably sufficient for the purpose in most cases. Such a nonpressure process merely requires a vat of suitable size fitted with steam coils to bring the temperature up to the desired point. If creosote is used it should be heated to about 180° C., while water solutions are brought to the boiling point and held there until the wood is heated to the center. If the vats are covered evaporation will not be excessive. The use of iron vats would simplify heating where steam is not available, since a fire beneath would accomplish the same purpose.

[4] Wood Preserving News 8 (Dec. 1930) 177. Published by the American Wood-Preservers' Association.

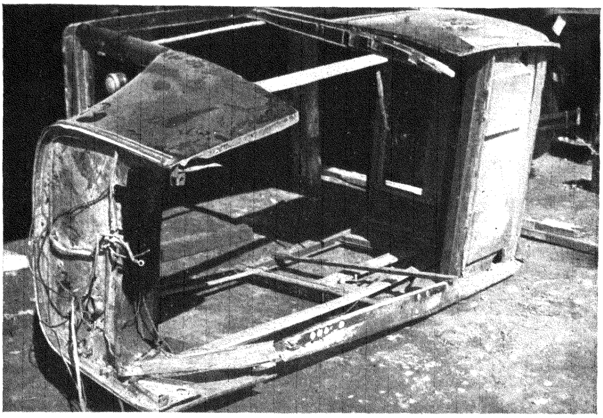
There is still another process in which the hot preservative is applied as a spray or is put on with a wire-bound paint brush. While this is hardly more than a make-shift it will increase the life of the timber to some extent, particularly if the ends of the timber, where joined, are allowed to absorb all the solution possible. This is better than no treatment at all, even with refractory wood such as guijo.

In Manila at the present time there is but one pressure treating plant,[5] handling principally large construction material. It is questionable, however, whether it would be feasible for the small repair man to have his comparatively small quantities of framed material treated on special order. Therefore, while we do not usually recommend the cutting and shaping of timber after treatment, it might be feasible, since apitong takes treatment so readily, to have the blanks cut out to approximate size, treated and held in stock either by retailers or by the plant. There would be some wastage in such a procedure, but the material cost in car-repair work is small compared to the labor cost.

Taking everything into consideration, however, the non-pressure vat treatment, while less reliable when not properly done, may be more convenient. If the treating equipment be located at or near the place where the repairs are being made it would be a simple matter to cut and fit the timbers for a job, drop them in the preservative vat for a few hours, then assemble them. Creosote-treated stock would not require more than a couple of days in the sun to dry the surface, but of course wood soaked in a water solution would require drying again to its original air-dry condition. Small pieces would season in a few days under cover during dry weather, but larger pieces would probably require rather too long a delay for economic operation. In consequence of this it would seem advisable to use creosote wherever possible.

[5] Atlantic, Gulf, and Pacific Company.

ILLUSTRATIONS



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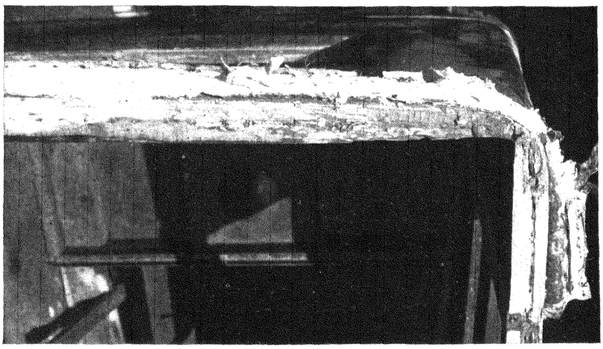

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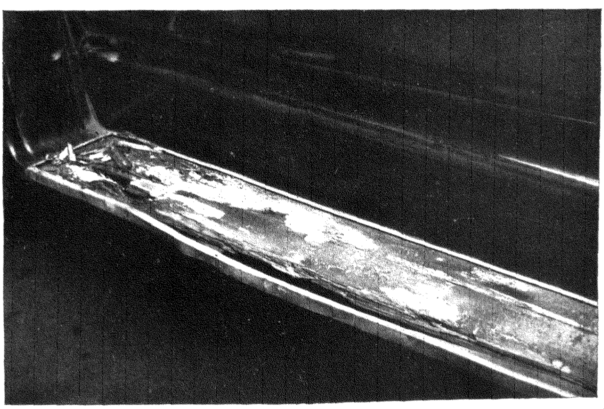

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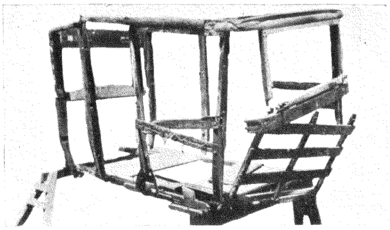
PLATE 1.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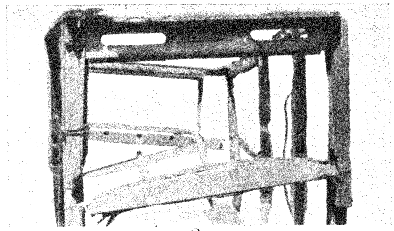
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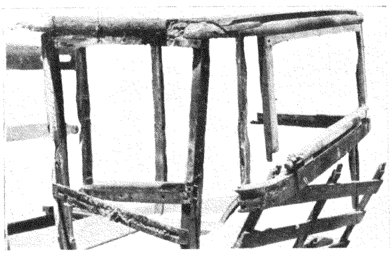
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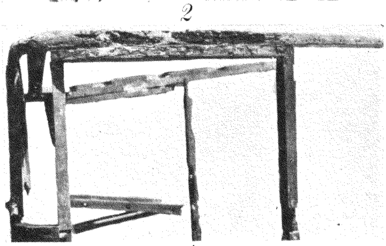
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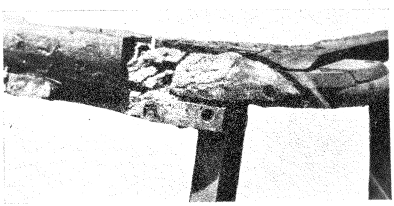
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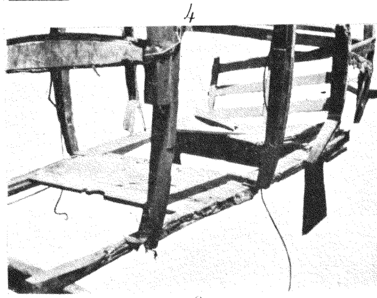
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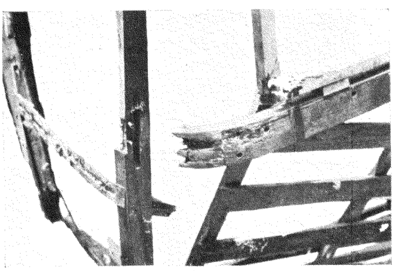
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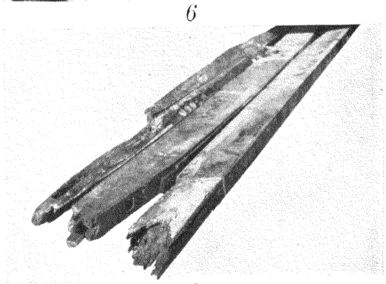
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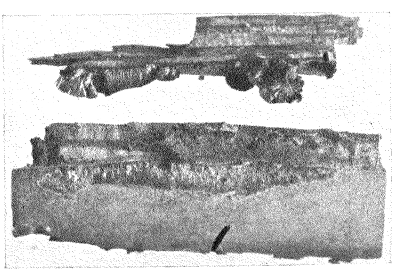
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PLATE 2.

COMPOSITION OF PHILIPPINE PEANUT OIL

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Of the Bureau of Science, Manila

ONE PLATE

High-grade peanut oil serves as a salad oil and also for the manufacture of oleomargarine. The lower-grade oil is suitable for making soap. The oil cake from peanut oil serves as an excellent cattle food as it contains a very high percentage of proteins and is easily digested.[1]

Recently oil from Philippine peanuts was investigated in this laboratory and the results showed that the Philippine oil has a composition very similar to that of American peanut oil. It would seem that there are promising prospects for the development of peanut cultivation in the Philippines.

The composition of peanut oil has been the subject of a number of investigations as pointed out by Jamieson, Baughman, and Brauns [2] in their paper on the composition of oil obtained from the white Spanish type of peanuts grown in South Carolina and also the Virginia type grown in Virginia. Their results showed that the composition of the saturated acids obtained from the glycerides of these two oils is about the same though the Spanish type oil contains a slightly larger amount of saturated glycerides than the Virginia type.

Information concerning the commercial aspects of the peanut industry such as the picking and handling of peanuts, by-products from crushing peanuts, and peanut oil, flour, butter, candy, and cookies may be obtained from various Government publications.[3]

Recently there have appeared two articles [4] which give a very good resume of the present status of the peanut industry.

[1] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 2 (1922) 314.

[2] Journ. Am. Chem. Soc. 43 (1921) 1372.

[3] Beattie, W. R., U. S. Dept. Agr. Bur. Plant Ind. Cir. 88 (1911).
Reed, J. B., U. S. Dept. Agr. Bull. 1096 (1922).
Beattie, W. R., U. S. Dept. Agr. Bur. Plant Ind. Cir. 98 (1912).
Bailey, H. S., and J. A. Le Clerc, Yearbook U. S. Dept. Agr. (1917) 239.

[4] Lynch, D. F. J., Journ. Chem. Ed. 7 (1930) 794, 1037.

Peanuts are cultivated to some extent in the Philippines, but to supply the local demand considerable quantities are also imported.

During the year 1929, 1,632,960 kilograms of peanuts valued at 256,833 pesos and 1,870,107 kilograms of peanut oil valued at 570,435 pesos were imported into the Philippines.[5] Most of these supplies come from China. Peanuts can be grown very easily in the Philippines, both from cuttings and seeds, especially in rotation with rice, corn, and other short-maturing crops. Since there is a considerable demand for peanuts and peanut oil it would seem that their cultivation should offer excellent prospects as a Philippine industry.

EXPERIMENTAL PROCEDURE

The peanuts used in this investigation were very kindly supplied by Dr. Nemesio Mendiola, of the College of Agriculture, University of the Philippines. They were the kind of peanuts known locally as the Valencia variety. The shells were first removed from the nuts after which the kernels were heated in an oven (80° C.) for about an hour. As the heating expels most of the moisture, the brown seed coats can then be removed easily from the kernels. After removing the seed coats the kernels were ground to a pulp, which was then cold-pressed to obtain the peanut oil. The oil was filtered to eliminate most of the fiber. After successive treatments (warming, shaking, and filtering) with kieselguhr, suchar, and talcum powder, a sample of oil was obtained with only a slight yellow color and a very high degree of purity. The yield of oil, calculated on the shelled nuts, was about 40 per cent.

The constants of Philippine peanut oil are given in Table 1. There are also included for comparison the constants of Spanish and Virginia type peanuts as determined by Jamieson, Baughman, and Brauns.

Figures for the Philippine oil represent the average of closely agreeing duplicate determinations. As shown by the data (Table 1) the physical and chemical constants of the Philippine oil are quite similar to those of American oils.

The saturated and unsaturated acids that occur as glycerides in Philippine peanut oil were separated by the lead-salt-ether

[5] Annual Report, Insular Collector of Customs, Manila (1930).

TABLE 1.—*Physical and chemical constants of peanut oil.*

Constants.	Philippine oil from Valencia variety of peanuts.	American oil.[a]	
		Spanish-type peanuts.	Virginia-type peanuts.
Specific gravity	0.9077, $\frac{30^\circ}{4^\circ}$C.	0.9148, $\frac{25^\circ}{25^\circ}$C.	0.9136, $\frac{25^\circ}{25^\circ}$C.
Refractive index	1.4676		
Iodine number	[b]101.3	90.1	94.8
Saponification value	191.5	188.2	187.8
Unsaponifiable matter per cent	0.29	0.22	0.27
Acid value	0.10	0.12	0.03
Saturated acids, determined per cent	[c]17.56	[d]21.4	[e]17.4
Unsaturated acids, determined do	77.44	73.4	77.7
Saturated acids, corrected do	17.12	20.6	16.4
Unsaturated acids, corrected do	77.89	74.6	78.7
Iodine number of unsaturated acids, determined	125.0	121.8	118.2

[a] Analyzed by Jamieson, Baughman, and Brauns.
[b] Determined by Hanus method.
[c] Iodine number 3.1.
[d] Iodine number 4.8.
[e] Iodine number 7.1.

method [6] in accordance with the suggestions of Baughman and Jamieson.[7] The results are recorded in Table 2.

TABLE 2.—*Separation of saturated acids from the unsaturated acids in peanut oil by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).[a]	Saturated acids (determined).	Unsaturated acids (corrected).	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	9.5764	7.3966	1.7000	77.24	[b]17.75	77.68	17.31
2	9.6772	7.5143	1.6805	77.65	[c]17.37	78.09	16.93
Mean				77.44	17.56	77.89	17.12

[a] Unsaturated acids: Saponification value 202.3; iodine number (Hanus) 125.0.
[b] Iodine number (Hanus) 3.10.
[c] Iodine number (Hanus) 3.15.

The composition of the unsaturated acids separated from peanut oil by the lead-salt-ether method was determined by means of the bromoderivative method.[8] This consists in converting the unsaturated acids into their bromo-derivatives, which

[6] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

[7] Cotton Oil Press 6 (1922) 41. Journ. Am. Chem. Soc. 42 (1920) 2398.

[8] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

are then separated by suitable solvents. The laboratory data for duplicate analyses are given in Tables 3 and 4.

TABLE 3.—*Determination of unsaturated acids of peanut oil (bromo-derivative method). Analysis 1.*

	Grams.
Sample of unsaturated acids	3.1512
Linolic tetrabromide insoluble in petroleum ether, melting point 113–114° C.	1.2013
Residue (dibromide and tetrabromide); bromine content, 40.37 per cent	4.3385
Dibromide in residue, 75.57 per cent	3.2786
Tetrabromide in residue, 24.43 per cent	1.0599
Total tetrabromide found	2.2612
Linolic acid equivalent to tetrabromide	1.0552
Oleic acid equivalent to dibromide	2.0918

TABLE 4.—*Determination of unsaturated acids of peanut oil (bromo-derivative method). Analysis 2.*

	Grams.
Sample of unsaturated acids	3.2970
Linolic tetrabromide insoluble in petroleum ether, melting point 113–114° C.	1.4786
Residue (dibromide and tetrabromide); bromine content, 39.60 per cent	4.2577
Dibromide in residue, 80.06 per cent	3.4087
Tetrabromide in residue, 19.94 per cent	0.8490
Total tetrabromide found	2.3276
Linolic acid equivalent to tetrabromide	1.0862
Oleic acid equivalent to dibromide	2.1748

A summary of these duplicate analyses (Tables 3 and 4) is given in Table 5.

In Table 6 is given the composition of the mixed unsaturated acids of Philippine peanut oil. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

Saturated acids.—The saturated acids were separated from Philippine peanut oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal

TABLE 5.—*Unsaturated acids of peanut oil; summary of analyses 1 and 2.*

Acid.	Analysis. 1	Analysis. 2	Mean.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	33.49	32.95	33.22
Oleic	66.38	65.96	66.17
Total	99.87	98.91	99.39

TABLE 6.—*Unsaturated acids.*

Acid.	Mixture of unsaturated acids. Composition.	Mixture of unsaturated acids. Proportions in original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	33.22	25.88	27.04
Oleic	66.17	51.54	53.86
Total	99.39	77.42	80.90

solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters (83.29 grams), which were yellow, were distilled under diminished pressure. A preliminary distillation at about 3 millimeters pressure was made. The esters (83.14 grams) were then redistilled at 3 millimeters pressure. Data on the distillation of the esters are given in Tables 7 and 8.

TABLE 7.—*First distillation of the methyl esters of the saturated acids; pressure, 3 millimeters; 83.29 grams of esters distilled.*

Fraction.	Temperature.	Pressure.	Weight.
	°C.	*mm.*	*g.*
A	170–178	3	14.69
B	178–181	3	16.25
C	181–185	3	12.94
D	185–196	3	11.73
Residue	----------	----------	27.53
Total	----------	----------	83.14

TABLE 8.—*Second distillation of the methyl esters of the saturated acids; pressure, 3 millimeters; 83.14 grams of esters redistilled.*

Fraction.		Temperature.	Pressure.	Weight.
From first distillation.	Second distillation.			
		°C.	mm.	g.
A and B	1	170–173	3	17.15
C	2	173–176	3	15.54
Do	3	176–186	3	14.15
D	4	186–203	3	7.92
Residue	5	203–225	3	8.24
Do	6	225–230	3	6.02
Do	7	230–238	3	11.87
	Residue			1.99
Total				82.88

TABLE 9.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction.	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters.		Mean molecular weight of saturated esters.
				Saturated.	Unsaturated.	
				Per cent.	Per cent.	
1	2.5	207.1	270.9	97.90	2.10	270.4
2	4.5	203.7	275.4	96.22	3.78	274.9
3	12.4	199.0	281.9	89.58	10.42	280.9
4	16.3	189.4	296.2	86.30	13.70	297.0
5	9.5	177.1	316.8	92.02	7.98	319.2
6	3.2	165.3	339.4	97.31	2.69	341.0
7	1.4	156.6	358.2	98.82	1.18	359.2

[a] Calculated iodine number of unsaturated methyl esters was 119. Calculated saponification value of unsaturated methyl esters was 192.6.

TABLE 10.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction.	Acids.							
	Palmitic.		Stearic.		Arachidic.		Lignoceric.	
	Per cent.	g.	Per cent.	g.	Per cent.	g.	Per cent.	g.
1	92.83	15.92						
2	76.25	11.85	15.07	2.34				
3	52.78	7.47	32.32	4.57				
4	3.80	0.30	78.44	6.21				
5			22.24	1.83	65.74	5.42		
6					68.73	4.14	24.56	1.48
7					39.11	4.64	55.84	6.63
Residue[a]								1.92
Total		35.54		14.95		14.20		10.03

[a] Residue assumed to be methyl lignocerate.

In Table 9, are given the analyses of fractions obtained in the second distillation of methyl esters. From the data, Table 9, there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 10 and were calculated in accordance with the methods outlined by Baughman and Jamieson in their investigations of Hubbard squash-seed oil [9] and also American peanut oil.[10]

In Table 11, are given the composition of the mixed saturated acids and the glycerides in the original sample of peanut oil corresponding to these acids.

TABLE 11.—*Saturated acids.* [a]

Acid.	Mixture of saturated acids.			Glycerides in original oil.
	Weight.	Composition.	Proportions in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Palmitic	35.54	47.57	8.14	8.54
Stearic	14.95	20.01	3.43	3.58
Arachidic	14.20	19.00	3.25	3.38
Lignoceric	10.03	13.42	2.30	2.38
Total	74.72	100.00	17.12	17.88

[a] When separated from peanut oil the corrected percentage of saturated acids was 17.12.

TABLE 12.—*Composition of peanut oil.*

Constituent.	Philippine peanuts (Valencia variety).	American peanuts.[a]	
		Spanish type.	Virginia type.
Glycerides of:			
Unsaturated acids—			
Oleic	53.9	52.9	60.6
Linolic	27.0	24.7	21.6
Saturated acids—			
Palmitic	8.5	8.2	6.3
Stearic	3.6	6.2	4.9
Arachidic	3.4	4.0	3.3
Lignoceric	2.4	3.1	2.6
Unsaponifiable matter	0.3	0.2	0.3
Total	99.1	99.3	99.6

[a] The composition of the American peanut oil was determined by Jamieson, Baughman, and Brauns, Journ. Am. Chem. Soc. 43 (1921) 1372.

[9] Journ. Am. Chem. Soc. 42 (1920) 156.

[10] Journ. Am. Chem. Soc. 43 (1921) 1372.

The composition of Philippine peanut oil is given in Table 12. There are also included for comparison the analyses of oil from the Spanish and Virginia types of peanuts.

The determined iodine number of Philippine peanut oil was found to be 101.3 and the determined saponification value 191.5. The calculated iodine number is 93.3 and the saponification value 188.4. The iodine and saponification values calculated from the composition of the oil agree fairly well with the determined values.

SUMMARY

The composition of Philippine peanut oil has been determined and the results (Table 12) indicate that the Philippine oil has a composition very similar to that of American peanut oil.

The percentage of linolic and palmitic glycerides is slightly higher in the Philippine oil than in the American oils while the percentage of the other glycerides is about the same or slightly lower.

Peanuts can be grown easily in the Philippines. Since Philippine peanuts yield an oil of high quality and about the same composition as American peanut oil, it would seem that there are promising prospects for the development of peanut cultivation in the Philippines.

ILLUSTRATION

PLATE 1. Peanuts growing at Agricultural College, Los Baños, Laguna Province, Luzon.

PLATE 1. PHILIPPINE PEANUT PLANTS.

NEW OR INTERESTING ORIENTAL FERNS

By EDWIN BINGHAM COPELAND

Of the Herbarium, University of California, Berkeley

LYCOPODIUM EDAÑOI Copel. sp. nov.

Phlegmaria laxa, caule deorsum fere 2 mm crasso, foliis ibidem tristichis remotis oblongis basi cuneatis, sursum gracile, foliis ovatis brevissime petiolatis 6 mm longis 3.5 mm latis, acutis haud acuminatis, basi rotundatis, coriaceis, viridibus; spicis infra furcam inferam sporophyllis lanceolato-ovatis subacuminatis plerisque alternantibus sporangias duplo superantibus aspersis, sursum sporophyllis triangulari-ovatis sporangias vix vel paullo superantibus acutis interdum imbricantibus; ramis foliosis 10-12 mm, spicis 1.5 mm latis.

PALAWAN, Mount Mantalingajan, *Bur. Sci. 77930 Edaño*, April, 1929.

Among Philippine species, this is nearest to *L. delbrueckii*, from which it differs in having ovate, instead of oblong, leaves, much more slender spikes with short sporophylls except at the base, and in the peculiar transition zone below the first dichotomy of the inflorescence. Among the more broadly construed species of the past, this might have been included in the *L. phlegmarioides* of Baker; hardly, however, in that of Gaudichaud, even if one ignores the description and figure of that species as having shoots bilaterally, not radially, symmetrical, with moderately dimorphous foliage leaves, as in *Diphasium*.

CYATHEA BONTOCENSIS Copel. sp. nov.

C. heterolobae affinis, trunco ignoto, stipite 20-25 cm longo, rhachique gracilibus supra basin paullo crassiorem 3-4 mm crassis, fulvis, minute asperulis, glabrescentibus; fronde 85 cm longa, 30 cm lata; pinnis infimis 6 cm longis, medialibus 20 cm longis, 5 cm latis, acuminatis, subsessilibus, rhachibus inferne praecipue deorsum paleis pallidis linearibus minute ciliatis 2-3 mm longis ornatis, apices versus paleis minoribus et pilis etiam albidis sparse vestitis; pinnulis sessilibus, usque ad 28 mm longis, 6 mm latis, obtusis vel acutis, apud basin paullo dilatatis et inciso-lobatis (infimis interdum ibidem pinnatis pin-

nula utroque latere una), alibi obscure serrulatis, costa inferne deorsum squamulis minutis fulvis, sursum pilis ornata, lamina glabra papyracea; venulis ca. 10-paribus, plerisque pinnatis; soris inframedialibus, magnis, indusio brunneo, mox fisso, persistente.

LUZON, Bontoc Subprovince, *Vanoverbergh 813*, November–December, 1910.

Nearly related to *C. heteroloba,* from which it is distinguished by more slender and naked stipe and rachis, narrower and less crowded pinules, and the presence of elongate paleæ on the minor rachises and of hairs on the costæ. The two form an isolated group.

CYATHEA CALOCOMA (Christ.) Copel.

A specimen collected by *Fenix, Bur. Sci. 12711,* at Sablong, Benguet, is essentially identical with those from Mindoro. This range would be commonplace in most genera, but is notable in *Cyathea.* Possibly this species is more common than is supposed, being unrecognized unless the base of the stipe is present.

CYATHEA CONTAMINANS (Wall.) Copel.

This is the commonest and largest of the Oriental tree-ferns, the least exigent as to habitat, and the only species evidently able to thrive in open places at moderate altitudes. It varies much in ampleness, which may be due entirely to environmental conditions. The largest specimens have just been brought in by Ramos, *Bur. Sci. 77170,* from Cagayan Province. The pinna is more than a meter long; the pinnules 15 cm, and the segments 4 mm wide, almost entire, and obtuse or only subacute. In the other direction, several collections run below the size typical of *C. clementis.*

Two large specimens collected by Ramos in 1912, in Camiguin de Misamis, a small volcanic island north of Mindanao, are remarkable in other respects. *No. 14872* has the pinna 95 cm long, pinnules 17 cm long and 3 cm wide, and falcate, acute segments, the sterile ones 4 mm wide, the fertile ones only 2.5 mm wide and separated by much more than their own width. *No. 14841* has pinnules 15 cm long and up to 4 cm wide, the fertile segments likewise narrow if merely serrate but more closely placed and, therefore, more numerous; but many of these segments are dilated by the elongation of the teeth, to a width of 5 mm, with the margin then fairly laciniate. The rachis of the pinna is pale-tawny; of the pinnule, dark-chestnut.

CYATHEA DUPAXENSIS Copel. sp. nov.

Trunco ignoto; stipite 30 cm longo, 1 cm crasso, atropurpureo, spinis vix 1 mm longis multis horrido, deorsum superne paleis atrocastaneis angustissimis 1-2 cm longis sparse vestito; rhachi deorsum castanea sursum fulva, glabra, inerme; pinnis infimis valde reductis, medialibus 45-50 cm longis, 14-15 cm latis, subsessilibus, acuminatis, rhachibus fulvis mox glabris sparsissime muriculatis; pinnulis maximis 8 cm longis (infimis paullo minoribus), 12 mm latis, subsessilibus, caudato-acuminatis cauda argute serrata, etiam ad basin vix pinnatis, costa inferne subglabra hinc inde squamulis minutis adspersa; segmentis obliquis, contiguis 6-7 mm longis, 3 mm latis, oblique subacutis; obscure serrulatis, pallide viridibus, papyraceis, ad costas inter soros sparse squamuliferis alibi glabris; venis 7-8 paribus, inconspicuis; soris stricte costularibus, 0.6 mm latis, exindusiatis vel squamulis subtensis.

LUZON, Nueva Vizcaya Province, Dupax, *Bur. Sci. 14291, McGregor,* March –April, 1912.

Distinguished from *C. callosa* by the absence of a developed indusium; from *C. caudata* by smaller, thinner frond, more densely spiny and less scaly base of stipe, and smaller sori. *Cyathea callosa* and *C. caudata* are doubtfully different.

CYATHEA EDAÑOI Copel. sp. nov.

C. melanophlebiæ affinis, minor, trunco 1-2 m alto, 10-15 cm crasso; stipite brevissimo, 1 cm crasso, rhachique atrocastaneis, muricatis spinis 0.5 mm longis sursum minoribus sparsis, deorsum paleis linearibus castaneis 6 mm longis squamulisque amorphis appressis sparse vestitis sursum glabrescentibus; fronde ovata, 45 cm lata, utrinque angustata, subtripinnata; pinnis infimis 5 cm longis haud remotis, infimis fructiferis 10 cm longis, medialibus 30 cm longis 11 cm latis, brevisti-pitulatis, rhachibus inferne fuscis glabris vel primo ad insertiones pinnularum parce paleatis; pinnulis infimis reductis, medialibus 6 cm longis 18 mm latis, subsessilibus, breviacuminatis, costis inferne nudis obscuris; segmentis infimis interse liberis (pinnulis secundariis) plerumque adnatis, sequentibus ala angusta confluentibus, 2.5-3 mm latis, obtusis, obscure crenulatis, nudis papyraceis, superne nigro-viridibus inferne olivaceis; venulis ca. 8-paribus; soris costularibus, magnis, indusio praecipue marginem versus aperto, denum persistente.

LUZON, Cagayan Province, summit of Mount Cagua, altitude

1,300 meters, *Bur. Sci. 78709 (type), and 78700 Edaño,* October–November, 1929.

This differs from *C. melanophlebia* Copel.,[1] as both species are known, in having decidedly smaller fronds, smaller spines but rougher rachis, and in being still more free of paleæ on any part of the frond; possibly it is a reduced mountain-top form. Another nearly related species is *C. halconensis.* The oldest species in the general group is *C. caudata.*

CYATHEA MERRILLII Copel. sp. nov.

Pseudohemitelia, trunco ignoto; stipite valido, atropurpureo, spinoso spinis 2 mm longis minute castaneo-furfuraceo; rhachi inerme, fusco-fulva, inferne glabra; pinna mediale 50-55 cm longa, 18 cm lata, subsessile, rhachi fulva, glabra, sparsissime muriculata; pinnulis medialibus 10 cm longis (infimis paullo minoribus), 16 mm latis, caudato-acuminatis, subsessilibus, ad basin pinnatis pinnulis II adnatis, alibi fere ad costam pinnatifidis, costa inferne squamulis minutis plerisque angustis sparsis vestita; segmentis haud contiguis, 10 mm longis, 2-3 mm latis, acutis, integris, tenuiter papyraceis, superne obscure, inferne laete viridibus, costis inferne squamulis minutis fulvis plerisque ovatis vestitis; venis 10-11-paribus, quarum ca. 8-paribus apud costam furcatis et ibidem soriferis; soris vix 0.5 mm latis, indusio ad squamam unilateralem basalem reducto.

LUZON, Benguet Subprovince, *Merrill 7819,* May, 1911.

Probably related to *C. mearnsii* of the same region, but thinner, with more entire segments, and clearly distinguished by the reduction of the indusium to a basal scale.

CYATHEA PUSTULOSA (Christ.) Copeland.

Cyathea pustulosa (Christ.) COPELAND, Philip. Journ. Sci. § C 4 (1909) 51.

BABUYAN, Camiguin Volcano, *Bur. Sci. 79615 Edaño,* March, 1930. Previously reported from Oshima and Formosa; new to the Philippines.

CYATHEA SQUAMICOSTA Copel. sp. nov.

Rhachi valida, fulva, minutissime asperula setis minutis obsita et tuberculis parvis paucis sparsa; pinna mediale sessile, 50-55 cm longa, 17 cm lata, abrupte in apicem lanceolatam pinnatam contracta, bipinnata, costa paleis fulvis sordidis lanceolatis 2 mm longis et ovatis vix 1 mm longis vestita, demum glabrescente, muriculata; pinnulis maximis 9 cm longis, acu-

[1] Philip. Journ. Sci. 38 (1929) 131.

minatis, sessilibus, basi 22 mm latis, ibidem pinnatis pinnulis[II] sessilibus, alibi fere ad costam pinnatifidis, costa inferne paleis descriptis hic persistentibus vestita; segmentis contiguis vel imbricatis, 3 mm latis, subfalcatis, apice rotundatis, integris, coriaceis, olivaceis, costis deorsum squamuliferis, aliter glabris; venis ca. 10-paribus, immersis et inconspicuis; soris costularibus, parvis; indusio mox in cupulam brevem reducto.

LUZON, Benguet Subprovince, Mount Pauai, *Bur. Sci. 8326 McGregor,* June, 1909, altitude 2,100 meters.

This species is well marked by the minute roughness of the rachis, the chaffiness, the very closely placed segments with rounded apices, and the small, costular sori. It is from a much-visited locality, and has been held twenty years for description, in the hope that more complete material with younger sori would be collected.

DRYOPTERIS CLEMENSIAE Copel. sp. nov.

D. gregis D. canescentis indusiis persistentibus, rhizomate repente, lignoso, 2 mm crasso, paleis paucis parvis atrocastaneis vestito, glabrescente; stipitibus approximatis 8-15 cm longis, versus basin squamulis paucis deciduis praeditis, alibi rhachibusque setis fulvis curvatis vix 1 mm longis, dense vestitis; fronde 10-15 cm longa, 4-5 cm lata, basi truncata, acuminata, segmento apicale deltoidea pinnatifida, alibi pinnata, atroviride, subcoriacea; pinnis utroque latere ca. 5, oppositis, sessilibus, lanceolato-ovatis, infimis haud reductis sed subdeflexis et basi plus minus angustatis, aliis basi cuneato-truncatis, acutis apice subfalcatis, serrato-lobatis, costis venisque minute pubescentibus; venatione irregulare, venulis extra seriem unam areolarum costalium plerisque liberis; soris sparsis ad venulas aut dorsalibus aut ad anastomonoses impositis, indusiis parvis, nudis, orbiculari-reniformibus.

LUZON, Isabela Province, Mount Moises, *M. S. Clemens 16490,* April, 1926. Type in *Herb. Univ. Calif. 285486.*

The irregular venation is suggestive of *D. otaria,* to which, however, there is no near affinity.

DRYOPTERIS PARASITICA (L.) O. K.

LUZON, Cagayan Province, Pagikpik, *Bur. Sci. 79644 Edaño,* on slopes in forest, altitude 1,000 feet.

Ferns bearing this name, or such predecessor-names as *Nephrodium molle,* are well known in Philippine collections, but this is the first known to me that fairly represents the species as now construed. It is identical with several Formosan collec-

tions, and like enough to those of southern China. The sori are a single pair at the bases of most segments, a second pair on some.

ATHYRIUM OPHIODONTUM Copel. sp. nov.

Diplazium caudice ignoto; stipite alto, 1 cm crasso, basi atrocastaneo paleis castaneis 2 cm longis basi 1 mm latis alibi angustissimis remote et minute spinoso-dentatis membranaceis contortis et intricatis vestito, sursum laete castaneo glabro, nullibi muricato; fronde magna, tripinnatifida, apice acuminata pinnatifida; pinnis medialibus 60 cm longis, 20 cm latis, caudato-acuminatis, stipitulis 5 cm longis protensis, rhachi potius sub lente quam sub digite muriculatis; pinnulis infimis quam sequentibus minoribus longiusque (5 mm) stipitulatis, medialibus usque et 11 cm longis, acuminatissimis, basi 3 cm latis, profunde pinnati fidis sinubus rotundatis integris angustis, costa inferne paleis paucis minutis vestita superne angustissime alata, ala ad basin venae quaeque interrupta et in dentem parvum protracta; segmentis oblongis, medialibus 10 mm longis, 3 mm latis, plerisque abrupte subfalcatis, tenuiter herbaceis, glabris, inciso-serratis dentibus approximatis acutissimis rectis vel inflexis; venulis hic simplicibus ca. 10-paribus (in pinnulis et segmentis inferioribus saepe furcatis et in dentes fissos protractis); soris costularibus, brevibus demum confluentibus, indusio angusto, pallido.

LUZON, Cagayan Province, Peñablanca, *Bur. Sci. 77188 Ramos,* May 12, 1929 "in forest streams, at low altitude." Type in Herbarium Bureau of Science.

This has the form and dissection of *A. blumei,* but the texture of the *A. umbrosum* group. *Athyrium costulisorum* and *A. tenuifolium* are Philippine species of similar size and texture; the former is fully tripinnate and the latter has muricate axes. The narrow, crinkly, brown (not black) paleæ and the very narrow and sharp teeth distinguish *A. ophiodontum* from all its relatives.

ASPLENIUM FINLAYSONIANUM Wall.

Our specimen is *A. macrophyllum* Sw. Christensen construes the name as having that application; and, likewise, seems certainly correct in construing *A. integerrimum* Hooker and Greville, Icones Filicum, Table 136, as the same species, in spite of Hooker's own testimony, Icones Plantarum, Plate 937, that it was an inaccurate presentation of the fern there (plate 937) described as *A. finlaysonianum* Wall. The latter is based on *Wallich 2682,* named *A. hookerianum* Wall. in the List—ac-

cording to our copy and according to Christensen, Index, page 115. Although both Hooker, loc. cit., Plate 937, and Mettenius, Asplenium, No. 149, cite *Wallich 2682* as the type or basis of *A. finlaysonianum* Wall., I mistrust their accuracy. It seems to me that the proper name or citation for their plant, instead of *A. finlaysonianum* Wall., or *A. finlaysonianum* Wall.; Hooker, as in Christensen's Index, is *A. finlaysonianum* Hooker, non Wallich.

The question then arises, could Hooker take Wallich's name, nomen nudum though it was, and, ascribing it to Wallich, give it valid application to a different plant? Or did Wallich's typification go with his specific name? If the latter is the case, the *A. finlaysonianum* of Hooker has no valid name. In his Species Filicum III, 272, published sixteen years after the plate in his Icones, Hooker's first citation is *Wallich 191*, from Penang and neighboring islands, as in the List, and his citation of *No. 2682* is explicitly indirect. One might readily assume that *No. 191* was a mixture, if it were not that all other published localities (and all of our specimens) are Himalayan.

ASPLENIUM TRIPINNATIFIDUM Copel. sp. nov.

Darea, ut videtur A. flaccido affinis, caudice ignoto, stipite longa rhachique straminee-viridibus superne profunde sulcatis paleis minutis lanceolatis sparsis; fronde 75 cm longa, 25 cm lata, acuminata, pallida, coriacea, inferne squamulis ovatis 0.4-0.7 mm longis ovatis clathratis castaneis sparsa tripinnatifida; pinnis infimis 8 cm longis, ovatis, medialibus 13 cm longis, 4.5 cm latis, valde caudatis, basibus stipitulatis oblique dilatatis, ad rhacheos applanatas vel anguste et crasse alatas pinnatis; pinnulis inferioribus 3.5 cm longis, 5 mm latis, oblique pinnatifidis, sequentibus (plerisque) linearibus incisis vel serratis, segmentis, resp. dentibus, 1 mm latis, acutis; venis omnino occultis; soris paucis, 2-3 mm longis, indusio 1 mm lato, persistente, ad marginem non attingente.

LUZON, Rizal Province, *Loher 14379,* April, 1913. Type in *Herb. Univ. Calif. 243202,* distributed from the herbarium Bureau of Science, Manila, as *Tapeinidium pinnatum.*

The texture, color, dissection, and squamules mark this as a member of the chiefly Austral group of *A. flaccidum* and *A. bulbiferum.* Taken in a broader sense the same group is represented by the widespread and common *A. tenerum.* It must be construed still more broadly to make it include *A. bullatum* Wall.; Mett., which has glabrous fronds of different texture and is very far from identical with *A. bulbiferum.*

STENOCHLAENA SMITHII (Fée) Underwood.

Lomariopsis smithii FÉE, Acrostichum, p. 71, pl. 33 f. 2 and 53.

We have perfectly typical material of this species from Cagayan Province, collected by Ramos in 1912, *Bur. Sci. 13887*. Because it occurs here in typical form, I believe that it is represented also by *Bur. Sci. 79645*, collected by Edaño at Pagikpik in the same province in 1930. This has the fertile pinna (only one is present) nearly as broad as in typical *S. smithii*, but the sterile pinnæ quite like those of *S. leptocarpa*. The rachis of the sterile frond is curiously wing-flattened toward the apex. This mixture of characteristics makes me suspect the distinctness of *S. smithii* and *S. leptocarpa*, neither of which is represented in herbaria by enough material to establish its uniformity. Of the two names, *S. leptocarpa* has priority, due to the apparent accident that Fée placed it in his section with "frondibus homomorphis," although describing them as dimorphous.

LINDSAYA LONGA Copel. sp. nov.

L. gregis L. macraeanae, pinnulis profundius incisis, lamina basiscopica imperfecte abscissa; rhizomate scandente, 2 mm crasso, paleis late lanceolatis castaneis vestito; stipitibus alternantibus castaneis, paleis paucis parvis ornatis, ca. 2 cm longis; fronde ca. 40 cm longa, 2.5-3 cm lata, utrinque attenuata, membranacea, rhachi straminea; pinnis plerisque imbricatis, basi acroscopice dilatatis, supra rhachin imbricatis, ibidem 6-7 mm latis, deinde usque ad apicem plerumque acutam angustatis, margine acroscopica prope basin $\frac{1}{4}$ ad costam, apicem versus profundius incisa, lamina basiscopica excisa, cum lobis infra apicem costam recipientam solitariis vel rarius nullis vel duo; venulis in lobo quoque aut solitariis aut duo in soro anastomosantibus, alibi liberis; soris fere marginalibus, lunulatis basi recurvatis, leviter si simplicibus, insigniter si venulas duas recipientibus.

PALAWAN, Mount Balagbag, *Bur. Sci. 77978 Edaño*, May, 1929.

The fronds are among the longest and narrowest in the group. The pinnæ are moderately protracted, less so than those of *L. apoensis* and *L. protracta*, the other species having pinnæ of the same general form. The affinity to these long-stipitate species is not as close as to the wide-spread *L. macraeana* and the Philippine *L. merrillii*, from both of which *L. longa* is distinguished by the form and deeper incision of the pinnæ and the form and position of the sorus. It is quite distinct from

L. fissa, likewise endemic in Palawan, which has more deeply cut pinnæ with truncate lobes, and sori not at all lunulate.

PHILIPPINE OLEANDRA

Pedicel short and stout, less than 5 mm long and shorter than stipe.
  Frond ciliate, pubescent.
    Frond acute at base .... *O. mollis.*
    Base abruptly contracted .... *O. benguetensis.*
  Frond not ciliate, glabrous or sparingly hairy........................ *O. neriiformis.*
Pedicel short, but stripe almost wanting.. *O. colubrina.*
Pedicel commonly more than 5 mm long.
  Frond sessile on the pedicel.. *O. maquilingensis.*
  Frond stipitate.
    Costa bearing long paleae.. *O. whitneii.*
    Costa not conspicuously paleate.
      Fronds firm, 30 cm or more long.
        Sori 1 mm wide .... *O. cumingii.*
        Sori about 2 mm wide.. *O. macrocarpa.*
      Fronds smaller .... *O. scandens.*

OLEANDRA BENGUETENSIS Copel. sp. nov.

Rhizomate rampante, 4-5 mm crasso, radices graciles indivisas praelongas emittente, paleis 6-8 mm longis lineari-lanceolatis integris vel subciliatis appressis nigrescentibus dense obtecto; pedicello 2-3 mm alto, valido, sparse paleaceo; stipite ca. 10 mm alto, costaque minute pubescentibus et sparsissime paleaceis; fronde anguste lanceolata, ca. 25 cm longa, 2-2.5 cm lata, acuminata, basim versus angustata basi ima truncata, margine angustissime cartilaginea minute ciliata, utraque facie sparse puberula, papyracea; soris 2-6 mm a costa irregulariter seriatis; indusio semiorbiculare sinu latissimo.

LUZON, Benguet Subprovince, Baguio, *Elmer* (*Bureau of Government Laboratories*) *6286,* May, 1904. Type in *Herb. Copeland 8225. Williams 1510,* also from Baguio, September 24, 1904, probably represents the same species, but has a shorter stipe, more paleaceous stipe and costa, and the sori closer to the costa and in more regular lines.

Distinguished from *O. scandens* by much stouter stems, with supporting roots, shorter pedicel and stipe, longer, narrower, less pubescent fronds, and indusia of different shape.

I have been abstaining from the publication of these (and other) species of *Oleandra,* partly while I awaited publication on *Oleandra* from Professor V. Goebel's laboratory, partly in the hope of learning what real *O. neriiformis* is. As I now recognize them, the published Philippine species are distinguishable by the above key, in which two or more species each are included in *O. neriiformis* and *O. colubrina.*

OLEANDRA SCANDENS Copel. sp. nov.

Rhizomate repente, 2-3 mm crasso, radices graciles enim filiformes ramosas multas emittente, ubique paleis persistentibus castaneis lineari-lanceolatis 5 mm longis integris vel sparse et irregulariter ciliatis supra basin peltatis dense vestito; pedicellis remotis vel subaggregatis, gracilibus, 10-20 mm altis; stipite plerumque quam pedicello longiore, costaque pubescentibus; fronde lanceolata, 10-20 cm longa, 25-30 mm lata, acuta, basi frondium minorum plerumque rotundata, majorum saepius acuta, breviter ciliata, utraque facie pubescente, herbacea vel subcoriacea; soris in lineam irregularem 2-5 mm a costa remotam instructis; indusio fere orbiculare versus costam sinu breve angust affixo.

LUZON, Benguet Subprovince, Baguio, *Elmer* (*Bureau of Government Laboratories*) *6513*, June, 1904. Type in *Herb. Copeland 8219; Williams 1509*, ibidem, August 1904; also from Benguet, *Copeland 1804, Bur. Sci. 2778 Mearns, For. Bur. 15950 Bacani.* PALAWAN, Silanga, *Merrill 9850.* While varying in size, base, length of stipe and pedicel, and remoteness of sori from the costa, these belong clearly to one species, well marked by its pubescence, shape of indusium, and by fairly long pedicel and stipe. I have chosen as the type of collection the one probably most widely distributed to herbaria.

This has been distributed as *O. cumingii* Presl, a species described with "frons fere sesquipedalis, coriacea," no mention of ciliate border, which is too conspicuous and characteristic easily to be overlooked, pubescence on the veins; *O. scandens* is persistently pubescent on lamina and veins.

Oleandra cumingii was based on *Cuming 60 partim,* as was also *O. macrocarpa* Presl. My specimen of this collection (sterile) can hardly be either of them, having a pedicel hardly 2 mm long. It is very hairy on surfaces and margin, and not at all coriaceous. An imperfect specimen in the herbarium University of California conforms perfectly to the diagnosis. To *O. cumingii* has been reduced *O. chinensis* Hance, described as *valde coriacea.*

GRAMMITIS LIMAPES Copel. sp. nov.

Species G. pubinerviae et G. (Polypodio) bulbotrichae affinis rubustior; rhizomate repente vel suberecto, 1.5-2 mm crasso, paleis ferrugineis ovatis 1-2 mm longis vestito; stipitibus approximatis, basi articulatis, 5-7 cm altis, 1 mm crassis, pilis 1 mm longis atropurpureis debilibus vestitis et ob baseos bulbo-

sas pilorum omnino horridis; fronde vulgo 15, rarius usque ad 30 cm alta, maxima 9 mm lata, utrinque sed ad basim imam abrupte angustata, integra, inferne praecipue ad costam deorsum setis minutis sparsissimis deciduis vestita aliter glabra, rigide coriacea, costa valida inferne prominente nigra; venis furcatis et, ubi satis lata frons, ramo basiscopico item furcato, ramo acroscopico breve; soris medialibus vel costæ paullo propioribus, fere superficialibus, 2 mm latis, 2-3 mm longis haud confluentibus, sporangiis setis nigris brevibus obsitis.

JAVA, Gedeh, Panggrango, *Copeland,* May, 1915 altitude 2,800 meters.

This differs from Gedeh specimens identified as *G. pubinervia* in being decidedly stouter and more rigid, with larger sori, as well as in the peculiarity of the stipes, exceedingly rough to the eye and to the touch. *Grammitis pubinervia* and *G. congener,* as I construe them, have ordinary hairs on the stipe, stiffer and rather longer than those of *G. limapes,* but without enlarged bases. The Philippine *G. bulbotricha, Polypodium bulbotrichum* Copel., Philip. Journ. Sci. **40** (1929) 309, is likewise less robust and with smaller, as well as more costal, sori.

GRAMMITIS MULTIFOLIA Copel. sp. nov.

Species jamdiu confusa G. pusillae Blume (Polypodio hirtello) affinis frondibus longe stipitatis distincta; caudice breve, erecto, parvo, basibus longe stipitatis distincta; caudice breve, erecto, parvo, basibus stipitum radicumque occulto, paleis etiam occultis lanceolato ovatis castaneis integris acutis vix 1 mm longis vestito; stipitibus confertissimis, filiformibus, fuscis, 2-3 cm longis, pilis atropurpureis usque ad 2.2 mm (plerisque ca. 1.2 mm) longis ornatis; fronde lineare, vulgo 6 cm rarius usque ad 9 cm longa, 4 mm lata, obtusa, deorsum sensim angustata, integra vel subintegra, praecipue inferne sparse setosa, subcoriacea, costa gracile inferne prominente; venis immersis, furcatis, ramo acroscopico vix basiscopico aequente et deorsum sorifero; soris parvis, superficialibus, fere orbicularibus, subcostalibus, sporangiis interdum setiferis.

JAVA, Mount Panggrango, *Copeland,* May, 1915 altitude 2,700 meters; ibidem, *Miller,* 1897.

I believe this to be *Polypodium alpestre* Blume non Spenn., subsequently regarded by Blume as a variety of his *Grammitis pusilla,* but ill depicted in Flora Javae II, Pl. 46, f. 5, which shows fronds too broad and too hairy. It differs from the typical form of that species in having long stipes, relatively nar-

rower and firmer fronds and comparatively remote sori. It seems to me decidedly more distinct than Blume's var. β *lasiosora,* construed as a species by Fée (*Grammitis nana*) and Hooker.

GRAMMITIS STENOCRYPTA Copel. sp. nov.

G. fasciatae similis, paleis angustis et soris elongatis profunde immersis costa remotis facile distinguenda, rhizomate breverepente, 1.5 mm crasso, paleis ferrugineis 4 mm longis, 1 mm latis dense vestito; stipitibus approximatis, 6-7 cm longis, 0.6-0.7 mm crassis, pilis paucis debilibus deciduis aspersis, basi nigro bulbosa paleis rhizomatis immersa articulatis; fronde lineare, 20 cm longa, 7-8 mm lata, utrinque attenuata sed apice ipsa obtusiuscula, integra, coriacea, inferne preaecipue ad costam pilis obscuris vix 1 mm longis mox omnibus caducis vestita deinde glabra; costa manifesta vix prominente; venis plerisque furcatis, ramo inferiore rarius iterum furcato, ramis in hydathodis inconspicuis terminantibus; soris inframedialibus, prima apparitione in cryptis 2.5-3, rarius usque ad 4, mm longis linearibus immersis, deinde sporangiis evolutis ellipticis oblique positis, sporangiis setis brevibus protectis.

JAVA, Gedeh, prope Kandang Badak, *Copeland,* May, 1915.

At first sight, much like *G. fasciata,* and perhaps in the past confused with that species. Too naked for confusion with *G. setosa* or *G. pubinervia,* longer stalked with longer sori, farther from the costa. *Grammitis longa* Fée can hardly be *G. fasciata,* as it has been construed, because *G. fasciata* is remarkable for its naked fronds and sporangia. The description of *G. longa,* 6th Mémoire, page 6, Plate 4, f. 1., is far inferior to its author's usual standard; it appears to differ from *G. stenocrypta* by having short stipes, more divergent and mostly twice forked sterile veinlets and the sori shorter, more costal, and more nearly parallel to the costa.

CAMPIUM SUBSIMPLEX (Fée) Copel.

Acrostichum zollingeri KZE., Bot. Zeit. 4 (1846) 419.

The suspicion that these are identical, expressed in Philip. Journ. Sci. 37 (1928) 357, can now be confirmed, as the California Herbarium has come into possession of a sheet of *Zollinger 1293.* Among the names borne by this sheet is *Leptochilus lanceolatus.*

EFFORTS TOWARD BIOLOGICAL CONTROL OF THE COMMON PINK MEALYBUG TRIONYMUS SACCHARI (COCKERELL) OF SUGAR CANE ON NEGROS

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and

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While the pink mealybug of cane is not of as much importance on Negros as it is on Luzon, still it is of sufficient importance to warrant attempts at more complete control. The insect is numerous at present, perhaps due to the unusually dry rainy season just experienced on Negros. The effect of the dry period is to inhibit the growth of the entomophagous fungus *Aspergillus* sp., which is of considerable importance in the natural control of the mealybug. The damage caused by mealybugs is occasioned by the fact that they extract the cane sap and reduce purities.

In order to try to decrease the number of mealybugs now in evidence and to try to provide insurance against any possible future outbreak of the pest, two kinds of natural enemies (from Laguna, Luzon) have been liberated in parts of Negros by the Entomology Department, Philippine Sugar Association.

One of the insects is *Scymnus* sp.[1] (order Coleoptera, family Coccinellidæ) a small brown lady-bird beetle measuring 1.5 millimeters in length. The fully grown larvæ are only 3 millimeters in length, their small size enabling them to get down between the leaf-sheath and stalk where the mealybug is most commonly found. They devour the young mealybugs, and are thus predators.

[1] According to a recent letter from Mr. Swezey this coccinellid is a species of the genus Pullus.

The senior author believes that he is the first to discover the *Scymnus* and its importance. The life history is completed in about a month.

The second natural enemy is a small wasp, *Anagyrus* sp. (order Hymenoptera, family Encyrtidæ), determined by Mr. O. H. Swezey, entomologist of the Hawaiian Sugar Planters' Association Experiment Station, from specimens sent to him. In Hawaii there is another species of encyrtid that perfectly controls the gray sugar-cane mealybug, but never attacks the pink mealybug. It is very difficult to find gray mealybugs in Hawaii to-day, but at one time they were so numerous that they were considered destructive. This control was effected only after the encyrtid became established in Hawaii. Efforts are now being made to establish this new species of *Anagyrus* in Hawaii and it is hoped that it will do as good work on the pink mealybug as the other encyrtid does on the gray mealybug.

This family of wasps lives as parasites of the ova, larvæ, or pupæ of various insects. In the present case, its eggs are laid in nearly mature or mature mealybugs, the larvæ probably devouring the entire body contents. The length of the female wasp, which is yellowish, is about 1 millimeter. The males, which are black, are noticeably smaller. The life history of the Philippine *Anagyrus* is from twelve to sixteen days depending on the temperature. This wasp was first reared at the College of Agriculture by one of the entomology students.

The senior author, temporarily stationed at the College of Agriculture making studies of mealybug natural enemies for the Hawaiian Sugar Planters' Association Experiment Station, devised methods of rearing the two species above mentioned. He advised the junior author of these methods and supplied him with a supply for establishment on Negros.

Starting with a small nucleus, Mr. F. P. Goseco, assistant entomologist, Philippine Sugar Association, has been able to rear large numbers of both kinds of natural enemies in the laboratory. They are reared in cloth-covered battery jars and are supplied with mealybugs as needed.

Up to December 23, 1930, colonies ranging in number from forty to one hundred individuals of each species have been liberated at the La Carlota Central Experiment Station field; at the Ma-ao Central parent field; at Hacienda San Jose, of Ramon Yusay, Binalbagan Estate; at Hacienda Panaquiao of Emilio Montilla, Isabela Sugar Company; at Hacienda Tarog of Ilde-

fonso Doronila, Santos-Lopez Central, Panay; at the Hawaiian-Philippine Company experimental field; and at the experimental field of the Bacolod-Murcia Milling Company.

Fields are selected in which mealybugs are plentiful, and which will not be harvested before January, 1931, thus allowing the natural enemies sufficient time to become established.

Stocks are maintained in the laboratory of the Philippine Sugar Association at La Carlota Central and further liberations will be made in the near future.

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THE KAHN TEST IN CLINICAL SYPHILIS [1]

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Since the discovery of the Kahn test, numerous papers discussing the correlation between this test and the Wassermann reaction have been published. However, in the majority of cases, the problem has been approached too much from the serological side of the question. The results are generally based on the total number of cases examined, without much attention being given to the presence or absence of clinical manifestations of syphilis. Comparatively few studies have been submitted in which the serological diagnosis was accompanied by clinical data, especially in regard to the type of syphilitic lesions. In the majority of these reports the percentage of agreement and disagreement is also based on the total number of cases examined, including a large number of nonsyphilitic cases.

It is the purpose of this paper to add something to the general knowledge of the Kahn reaction and to judge the merits of the test in comparison with the water-bath and ice-box Wassermann fixation methods, as performed in the serological laboratory of Johns Hopkins Hospital. The author tried to place himself in the position of a clinician, who first makes the clinical diagnosis and then receives further information from the serological laboratory.

In these records, the writer has endeavored to demonstrate the relative sensitiveness of the Wassermann and the Kahn tests by means of a series of syphilitic cases only, corroborated in each case by the clinical history of the patient.

Parallel Wassermann and Kahn tests were also made with a smaller number of cases showing different clinical types of syphilis that had been submitted to several courses of treatment. The object here was to get an idea of the merits of these reactions as a guide in the treatment of syphilis.

[1] This paper is the result of work done in the School of Hygiene and Public Health, Johns Hopkins University, Baltimore.

The clinical material consisted of syphilitic cases entering the Department of Syphilology in the dispensary of Johns Hopkins Hospital. The majority of these cases were selected and diagnosed by Dr. H. Hopkins, of the clinical staff of the hospital. Only a few of the unselected cases submitted to the serological laboratory are included.

The technic followed in the Kahn test is the procedure described by Kahn in the latest edition of his book [2] in which incubation is almost entirely eliminated and readings are made shortly after mixing the serum and the antigen. In the original method, the weaker reactions required an overnight incubation before the final reading was made.

The antigen used in the experiments here reported was prepared with great care and titrated against a standard antigen obtained from Doctor Kahn's laboratory.

Finally, the comparative tests were made upon the sera from twenty-four hours to four days after bleeding the patients. Under these circumstances, it was found that the age of the serum did not interfere with the results of the precipitation test if the material was kept properly in the ice box.

The Wassermann reaction was performed in the laboratory of Johns Hopkins Hospital.[3] A 0.2 per cent cholesterinized beef-heart antigen was used, and the fixation carried out both in the water bath and ice box. In the water-bath method, a first incubation (water bath) of thirty minutes was allowed for fixation. In the ice-box method, this first incubation was carried out in the refrigerator for three hours. After the first incubation the hæmolytic system was added; for all the tubes were replaced in the water bath at 37° C. for one-half hour before the readings were made.

It will be seen from Table 1 that the cases have been classified in seven groups, as follows:

1. Primary syphilis. Cases with early or more or less healing chancres.
2. Secondary syphilis. Cases with different varieties of skin and mucous membrane lesions.
3. Tertiary syphilis. Skeletal, visceral, and late cutaneous involvements.

[2] Serum Diagnosis of Syphilis by Precipitation; governing principles, procedure, and clinical application of the Kahn precipitation test. Williams and Wilkins Co. (1925).

[3] A complete description of the method is given in an article by Albert Keidel and Joseph D. Moore, The Wassermann reaction in the Johns Hopkins Hospital, Johns Hopkins Bull. 34 (January, 1923) 16.

4. Latent syphilis. Cases in which the Wassermann reaction has been found repeatedly positive. The majority of these cases gave history of chancres, secondaries, or other manifestations and at the time when the blood examination was made were inactive.
5. Syphilis of the central nervous system. Cases of neuro-recurrens, general paresis, tabes, asymptomatic, and other nonspecified lesions of the central nervous system.
6. Congenital syphilis.
7. Nonsyphilitic. Cases with various skin diseases and other clinical manifestations (impetigo, pytiriasis rosea, acne, eczema, dermatitis seborrheicum, carcinoma, pregnancy, abscesses, arteriosclerosis, colloid goiter, fractures, chronic myeloid leukemia, psychoneurosis, endocarditis, and pericarditis).

TABLE 1.—*Showing the number of cases examined and the various types of the disease.*

Type of syphilis.	Number of cases.	Remarks.
Primary	11	Syphilitic chancres. Some positive for treponema.
Secondary	54	Skin lesions, 34 cases. Skin and mucous membranes, 11 cases. Early skin with chancre, 4 cases. Mucous membrane lesions, 5 cases.
Tertiary	29	Skeletal lesions, 9 cases. Visceral (vascular, cardio-vascular, eye) 11 cases. Skin late lesions, 9 cases.
Latent syphilis	35	
Central nervous system	21	Neuro-recurrens, 1 case. General paresis, 4 cases. Tabes, 5 cases. Asymptomatic and not specified, 11 cases.
Congenital syphilis	2	
Nonsyphilitic	68	
Total	220	

The number examined was one hundred fifty-two syphilitic and sixty-eight nonsyphilitic cases. It must be noted, however, that one hundred forty-one cases of the syphilitic series had received treatment before the time the Wassermann and the Kahn tests were performed. In the syphilitic series there were only eleven untreated cases with secondary lesions, and the serological results in these cases showed complete agreement, as demonstrated in Table 5*a*. No false results were found in the sixty-eight nonsyphilitic cases, and the results of the three reactions also showed complete agreement.

Primary syphilis.—Table 2 shows that in eleven cases of primary syphilis the Kahn test gives more definitely positive reactions than the Wassermann water-bath and ice-box fixation methods.

TABLE 2.—*Showing the results of the Wassermann and Kahn tests in eleven cases of primary syphilis.*

[Very strongly positive, ++++; strongly positive, +++; moderately positive, ++; slightly positive, +; doubtfully positive, ±; negative, —.]

Number of cases.	Kahn.	Wassermann.	
		Water bath.	Ice box.
1	++++	++++	++++
1	++++	±	++++
1	++++	—	++++
1	++++	—	++
1	+++	—	+ J-11313 (I-26-29).
2	+++	—	—{J-15556 (II-19-29). J-15121 (II-18-29).
1	+	—	—
3	—	—	—

Case J-11313. November 21, 1928. Patient had a ragged crusted ulcer on shaft and a soft dirty shallow ulcer in coronal sulcus. Noticed sore in penis November 3, 1928; exposure six weeks prior. Sore grew worse until present. Dark field, negative. Wassermann 4-4, November 21, 1928. Clinical diagnosis: Syphilis, primary. Seropositive.

TABLE 3.—*Showing the record of treatment and reactions of cases J-11313.*

Date.	Treatment.	Dose.	Wassermann.		Kahn.
			W. B.	I. B.	
		g.			
November 21, 1928	Neoarsphenamine	0.60	++++	++++	
December 1, 1928	do	0.90	++++	++++	
January 11, 1929	do	0.40	++++	++++	
January 18, 1929	do	0.40			
January 26, 1929	do	0.40	—	+	+++

Case J-15556. Patient came to the hospital January 26, 1929, with an ulcer 0.5 by 0.5 centimeter on foreskin near corona. It was covered with a dirty yellow slough and was very tender. Had been treated locally with calmin and peroxide. Dark field, negative. Wassermann, negative (January 26, 1929). No treatment. February 4, 1929, Wassermann = Neg. Neg. February 19, 1929, the penile lesion had a characteristic rolled, indurated border of the syphilitic chancre. Dark field, positive for treponemas. Wassermann Neg. Neg. Kahn 3 (February 19, 1929). One injection of arsphenamine given February 19, 1929. February 26, 1929, Wassermann = Neg. Neg. Kahn 3. Diagnosis: Primary syphilis.

Case J-15121. January 18, 1929, a subacute gonococcus infection. The urethral orifice eroded by a superficial dime-sized soft ulcer. Bilateral

small, hard, indolent, inguinal buboes. Dark field from ulcers showed many nonmotile treponemas. Wassermann reaction = Neg. (water bath) = 4 (ice box). Clinical diagnosis: Syphilis primary. Seropositive.

TABLE 4.—*Showing the record of treatment and reactions of case J-15121.*

Date.	Treatment.	Dose.	Wassermann.		Kahn.
			W. B.	I. B.	
		g.			
January 18, 1929	Neoarsphenamine	0.90			
January 25, 1929	do	0.90	—	+	
February 18, 1929	do	0.90	—	—	+++

Secondary syphilis.—In the forty-three cases of secondary syphilis, the Kahn test was found also more sensitive than the two Wassermann methods employed. See Table 5*a*.

TABLE 5*a*.—*Showing the results of the Wassermann and Kahn tests in forty-three cases of secondary syphilis.*

[Very strongly positive, ++++; strongly positive, +++; moderately positive, ++; slightly positive, +; doubtfully positive, ±; negative, —.]

Number of cases.	Kahn.	Treated cases.	
		Water bath.	Ice box.
16	++++	++++	++++
2	++++	++	++++
2	++++	+	++++
2	++++	—	++++ J-16015 (V-3-29).
1	++++	++	+++
1	++++	—	++
7	++++	—	— {J-11391 (III-13-29). J-16247 (IV-10-29).
1	++++	—	— U-7696 (III-20-29).
1	++		
11	—	—	—
UNTREATED CASES			
11	++++	++++	++++

Case J-16015. February 12, 1929, complaint of pain in the joints. Kernels behind ears. Examination showed three large mucous patches on hard and soft palate. Treponemas were demonstrated in these lesions. Post auricular glands very large and firm. Old scars on prepuce. Palms and soles showed dark, firm papules. Clinical diagnosis: Secondary cutaneous palmar and plantar. Arthralgia.

TABLE 5b.—*Showing the record of treatment and reactions of case J-16015.*

Date.	Treatment.	Dose.	Wassermann.		Kahn.
			W. B.	I. B.	
		g.			
February 12, 1929	Arsphenamine	0.60			
February 20, 1929	do	0.60			
February 27, 1929	do	0.60	++++	++++	
March 6, 1929	do	0.60	—	++++	++++
March 13, 1929	do	0.40	—	++++	++++
March 20, 1929	do	0.40	—	+	++++
April 5, 1929	do	0.40	—	+++	++++
April 12, 1929	do	0.40	—	++++	++++
April 19, 1929	Bismuth	0.20	—	—	++
April 26, 1929	do	0.20	—	—	++++
May 3, 1929	do	0.20	—	—	++++

Case J-11391. January 14, 1929, numerous follicular indurated papules over bearded region of face, some with tendency to be annular. No lesions on mucous membrane. Penis distorted by large multiple scars and crusted ulcers. Dark field from one of these, negative. Wassermann 4-4 (January 14, 1929). Clinical diagnosis: Secondary early cutaneous folliculo-papular.

TABLE 6.—*Showing the record of treatment and reactions of case J-11391.*

Date.	Treatment.	Dose.	Wassermann.		Kahn.
			W. B.	I. B.	
		g.			
January 15, 1929	Neoarsphenamine	0.90	++++	++++	
January 22, 1929	do	0.90	++++	++++	
January 29, 1929	do	0.75	++	++++	
February 5, 1929	do	0.75	++++	++++	
February 12, 1929	do	0.75	++++	++++	
February 19, 1929	do	0.75	++++	++++	
February 26, 1929	do	0.75	—	+	
March 5, 1929	do	0.75	—	—	++++
March 12, 1929	Bismuth	0.20	—	—	++++
March 13, 1929	do	0.20	—	—	++++

Case J-16247. February 13, 1929, a condylomata on right inner thigh, fading papular lesions (about two to three months duration) over arms, palmar and plantar macules. Patient stated that her husband had similar eruptions before she had and was receiving treatment. Wassermann = 4-4. Clinical diagnosis: Secondary early pigmentary condylomata.

TABLE 7.—*Showing the record of treatment and reactions of J-16247.*

Date.	Treatment.	Dose.	Wassermann.		Kahn.
			W. B.	I. B.	
		g.			
February 13, 1929	Neoarsphenamine	0.75	++++	++++	----
February 20, 1929	do	0.75	----	----	----
February 27, 1929	do	0.75	++++	++++	----
March 6, 1929	do	0.75	----	++++	----
March 13, 1929	do	0.75	++++	++++	----
March 20, 1929	do	0.75	----	----	++++
April 4, 1929	do	0.75	----	----	++++
April 10, 1929	Bismuth	0.20	----	----	++++
April 19, 1929	do	0.20	----	----	+++

Case U-7696. January 30, 1929. Complained of soreness on genitalia. Several eroded condylomata lata on vulva were found. Treponemas found by dark field. Wassermann = 2-4. Clinical diagnosis: Secondary early condylomata.

TABLE 8.—*Showing the record of treatment and reactions of case U-7696.*

Date.	Treatment.	Dose.	Wassermann.		Kahn.
			W. B.	I. B.	
		g.			
January 30, 1929	Neoarsphenamine	0.75	----	----	----
February 6. 1929	do	0.75	+	++++	----
February 13, 1929	do	0.75	++	++++	----
February 20, 1929	do	0.75	----	----	++++
February 27, 1929	do	0.75	+	++++	++++
March 6, 1929	do	0.75	—	—	++++
March 13, 1929	do	0.75	—	++	++++
March 20, 1929	do	0.75	—	—	++++
March 27, 1929	Bismuth	0.20	—	—	+

Tertiary syphilis.—In the twenty-nine cases of tertiary syphilis, as shown in Table 9, the Kahn test was much more sensitive than the Wassermann reaction, especially the water-bath method. In the late cutaneous involvements, the sera examined agree almost completely with the three methods. In the skeletal and visceral syphilis, the Kahn test is definitely more sensitive than the water-bath method. See Table 9.

TABLE 9.—*Showing the results of the Wassermann and Kahn tests in twenty-nine cases of tertiary syphilis.*

[Very strongly positive, ++++; strongly positive, +++; moderately positive, ++; slightly positive, +; doubtfully positive, ±; negative, —.]

Type.	Number of cases.	Kahn.	Wassermann.	
			Water bath.	Ice box.
Skeletal (9 cases)	3	++++	++++	++++
	1	++++	+	++++
	1	+++		++++
	1	++++	—	++ J-12727.
	1	++++	—	— (G-83908 (I-23-1929).
	2	—	—	—
Visceral (11 cases)	2	++++	++++	++++
	2	++++		++++
	1	++++	—	++++
	1	++++	—	++
	1	++++	—	— No. 20149 (I-10-1929).
	1	+++	—	++++
	1	++	—	++++
	1	±	—	—
	1	—	—	—
Late skin (9 cases)	3	++++	++++	++++
	1	++++	+++	++++
	1	++++	++	++++
	1	+	—	—
	3	—	—	—
Total	29			

Case J-12727. Patient complained of pain over right side of head from eye to ear, duration four months. A definite area of tenderness to pressure above the zygomatic bone was found. No tenderness over sinuses or mastoids. Ptosis of right eye, complete inability to move right eye ball. Pupils equal, circular. Vision of both eyes apparently normal by rough tests. Fundi, moderate arteriosclerosis. No change in retina of right eye. No facial paralysis but deviation of the mouth to the right upon showing teeth. On genitalia or dorsum of prepuce there was a definite indurated scar 1 centimeter in diameter. Wassermann = Neg. 2. Kahn 4. Diagnosis: Syphilis. Periostitis of orbit?

Case G-83908. June 16, 1923, gumma of palate and central nervous system (VIII nerve) was diagnosed. Under treatment her deafness (right side) cleared up entirely. Patient received very irregularly three courses of arsphenamine and two of mercury and potassium iodid. The Wassermann test was positive at all times. February 10, 1928, patient was given several injections of arsphenamine and bismuth up to January 23, 1929. January 23, 1929. Wassermann = Neg. Neg. Kahn 4.

During the above second period of treatment the Wassermann became negative for the first time with ice-box method June 22, 1928, and remained

so until January 23, 1929, except on the following dates: October 19, 1928, Wassermann = Neg. 3. January 4, 1929, Wassermann = Neg. 3. Diagnosis: Old gummatous perforation of soft palate.

Case 20149. Patient was operated on October 15, 1928, for a myoma of the uterus (hysterectomy). Very satisfactory post-operative convalescence. Came back to the hospital on December 8, 1928. Physical examination showed an enlargement of heart to the left, apical systoic murmur. Aortic second sound somewhat coarsened. Murmur not transmitted to vessels of neck. Radial arteries thickened. Blood pressure 115/75 left, 125/85 right. No evidence of syphilitic infection. August 22, 1928, Wassermann reaction = Anticomplementary. August 28, 1928, Wassermann reaction = Positive (water bath = 4; ice box = 2). December 11, 1928, Wassermann reaction = Negative.

Two successive Wassermann tests done in the laboratory of the hospital, one on December 11, 1928, and the other on January 10, 1929, using the ice-box method were also negative. A Kahn test was performed at the latter date and the result was 4 plus. An X-ray examination showed dilatation of the aorta and enlargement of the heart.

March 6, 1929, the patient was given an injection of neoarsphenamine (0.30 gram), and the Wassermann test then became strongly positive (4–4). The treatment was continued until April 10, 1929. During the course of this treatment the Wassermann test was constantly 4–4. Impression. Syphilis (seropositive).

Myocardial degeneration with some changes in the aorta (etiology may be lues, arteriosclerosis; uterine myomata may have some bearing).

Asymptomatic cases.—In this group of asymptomatic cases, as demonstrated in Table 10, the Kahn test is again more sensitive than the Wassermann reaction. This shows that the Kahn test is perhaps a more dependable procedure than the complement fixation for the diagnosis of chronic syphilitic cases.

TABLE 10.—*Showing the results of the Wassermann and Kahn tests in thirty-five cases of latent syphilis.*

[Very strongly positive, ++++; strongly positive, +++; moderately positive, ++; slightly positive +; negative, —.]

Number of cases.	Kahn.	Wassermann.	
		Water bath.	Ice box.
17	++++	++++	++++
1	++++	+++	++++
1	++++	—	++++
1	++++	—	++
1	++++	—	— J-2506 (I-23-1929).
2	+++	—	— H-93343 (I-15-1929).
2	++	—	—
3	+	—	— H-13182 (XI-7-1928).
7	—	—	—

Case J–2506. In 1911 at the age of 16, patient had a genital sore that was thought to be a primary lesion. There was no record of her having received any antisyphilitic treatment. She came back in 1922 complaining of generalized pruritus. A diagnosis of syphilis (seropositive) was made at that time. Out of four Wassermann tests performed, two were positive and two were negative. She received 3 doses of diarsenol and did not present herself again until August 17, 1928, when she complained of essentially the same, generalized pruritus. Patient's history was essentially negative, except for shortness of breath on exertion and micturition (5 or 6 times each night). Blood and spinal Wassermann were negative.

October 12, 1928, patient was given an injection of silver arsphenamine, 0.1 gram. October 19, 1928, the Wassermann showed water bath = negative; ice box = 1. Another injection October 19, 1928, of silver arsphenamine 0.1 gram. December 7, 1929, the Wassermann showed water bath = negative; ice box =1. Another injection October 19, 1928, of silver arsphenamine 0.1 gram. December 7, 1929, the Wassermann was Neg.–Neg. The patient was given six injections of arsphenamine (0.20 gram each), and one injection of bismuth (0.20 gram) up to January 23, 1929. Repeated Wassermann during this treatment remained negative.

On January 23, 1929, blood was tested again for Wassermann and Kahn. The results were the following: Wassermann Neg.-Neg. Kahn 4. Diagnosis: Syphilis Wassermann reaction (1922).

Case H–93343. History of syphilis. February 17, 1928, the Wassermann reaction showed water bath = negative; ice box = 4. Patient was given arsphenamine and bismuth and the Wassermann reaction in July, 1928, became completely negative. January 15, 1929, patient came again to the hospital. This time the Wassermann reaction was found negative, but the Kahn test positive (+++). At this time, however, there was no evidence of syphilis on physical examination. Diagnosis: Latent Wassermann reaction, late (1928).

Case H–13182. Patient had one premature spontaneous delivery (stillborn baby) on December 4, 1924. Denies venereal infection. Wassermann = 4–4 on December 16, 1925. Positive. (Patient's husband received antisyphilitic treatment at that time in the dispensary of the hospital.) Patient came for the second time to the hospital in 1927. Started treatment with silver arsphenamine, neoarsphenamine and bismuth from February 23, 1927, to January, 1928. During the course of this treatment the Wassermann remained negative.

November 7, 1928, Wassermann Neg.-Neg, Kahn test 1. Diagnosis: Latent syphilis (1925).

Syphilis of the central nervous system.—In the twenty-one cases examined, the Kahn test is undoubtedly more sensitive than the Wassermann water-bath method.

Congenital syphilis.—In the two cases examined the results were identical.

TABLE 11.—*Showing the results of the Wassermann and Kahn tests in twenty-one cases of syphilis of the central nervous system and in two cases of congenital syphilis.*

[Very strongly positive, ++++; strongly positive, +++; moderately positive, ++; slightly positive, +; negative, —.]

Type.	Number of cases.	Kahn.	Wassermann.	
			Water bath.	Ice box.
Neurorecurrens	1	++++	++++	++++
General paresis (4 cases)	1	++++	—	++ H-811 (XII-10-28).
	2	++++	—	— H-56170 (I-23-29).
	1	—	—	—
Tabes (5 cases)	1	++++	++++	++++
	1	++++	—	—
	1	+	—	—
	2	—	—	—
Asymptomatic and nonspecified (11 cases)	3	++++		
	1	++++	++++	++++
	1	++++	+	++++
	1	+++		++++
	1	++	—	++
	1	+	—	—H-30276 (XI-5-1928).
	3	—	—	
Congenital	2	++++	++++	++++

Case H-811. Patient in 1924 complained of nervousness, speech trouble, and weakness. Denied lues and gonorrhea. Had headaches and difficulty of vision for five years. Pupils irregular. No reaction to light. Marked tremor of tongue and facial muscles. Marked slowing and slurring of speech, but test phrases were pronounced quite well when patient really tried. Tremor of hands. Patient's memory quite good.

Globulin test 4. Wassermann of spinal fluid (positive, 1 cubic centimeter). Colloidal mastic, 5555554321.

Patient received treatment with tryparsemide from May 23, 1924, to January 20, 1925. Patient came back to the hospital December 10, 1928. At this time Wassermann showed water bath = Neg., Ice box = 2. The Kahn test = 4. Diagnosis: General paresis.

Case H-56170. Patient was seen first in psychiatric clinic August 17, 1926, with a complaint of loss of consciousness and failing memory.

Globulin 4. Wassermann, water bath = Neg., Ice box = 4. Mastic test, 5543210000.

Treatment began September 15, 1926, with neoarsphenamine-tryparsemide and bismuth. Blood Wassermann remained negative as a result of treatments in October, 1928, up to January 23, 1929.

January 23, 1929, Wassermann Neg. Neg., Kahn 4. Diagnosis: Central nervous system syphilis (paresis). Aortic insufficiency.

TABLE 12.—*Showing the influence of treatment upon the Kahn and Wassermann tests in eleven cases with different varieties of syphilis.*

[4=++++; 3=+++; 2=++; 1=+; —=negative.]

Type of syphilis.	Number of cases.	Clinical diagnosis.	Treatment.																	
			First.			Second.			Third.			Fourth.			Fifth.			Sixth.		
			K	Wass.		K	Wass.		K	Wass.		K	Wass.		K	Wass.		K	Wass.	
				WB	IB		WB	IB		WB	IB		WB	IB		WB	IB		WB	IB
Primary	1	Chancre (3 weeks duration)	4	4	4	4	4	4	4	4	4	4	2	4	3	—	2	4	—	2
Do	1	Early cutaneous macular	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Do	1	Early cutaneous maculo papular	4	4	4	4	—	4	4	2	4	4	—	3	3	—	3	3	—	—
Secondary	1	Cutaneous (condylomata)	4	4	4	4	4	4	4	4	4	4	1	1	4	—	3	4	—	2
Do	1	Early papular with chancre	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Do	1	Early mucous membrane with chancre	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	4
Do	1	Early papular	4	4	4	4	4	4	4	—	1	3	—	—	3	—	—	+	—	—
Do	1	Late skin nodular	4	2	4	4	—	4	—	—	4	4	—	4	4	—	4	—	4	4
Tertiary	1	Bone. Osteitis of skull and mandible	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Do	1	C. N. S. (8th nerve)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Do	1	Latent Wassermann. Has congenital syphilitic children	4	4	4	4	4	4	4	4	4	4	4	4	4	—	4	4	—	2

Type of syphilis.	Number of cases.	Clinical diagnosis.	Treatment.												Drug.	Total amount given.
			Seventh.			Eighth.			Ninth.			Tenth.				
			K	Wass.		K	Wass.		K	Wass.		K	Wass.			
				WB	IB		WB	IB		WB	IB		WB	IB		g.
Primary	1	Chancre (3 weeks duration)	K	—	—	4	—	—	3	—	—	3	—	—	Neoarsph	6
Do	1	Early cutaneous macular	4	1	4	4	4	4	2	—	1	2	—	—	do Bismuth	2.52 0.60
Do	1	Early cutaneous maculo papular	3	—	—	3	—	—							Neoarsph	3
Secondary	1	Cutaneous (condylomata)	4	—	4	4	—	2	4	—	—	4	—	—	do Bismuth	3.55 0.60
Do	1	Early papular with chancre	4	—	—										Neoarsph	6
Do	1	Early mucous membrane with chancre	4	1	3	4	—	1	3	—	—	2	—	—	do Bismuth	5.70 0.40
Do	1	Early papular													Neoarsph	4.20
Do	1	Late skin nodular	4	4	4	4	4	4							Arsph Neoarsph	1.80 1.20
Tertiary	1	Bone. Osteitis of skull and mandible	4	1	4	4	4	4	4	—	4	4	—	4	Arsph Neoarsph Bismuth	2 0.45 0.80
Do	1	C. N. S. (8th nerve)	4	4	4	4	4	4	4	4	4	4	4	4	Arsph Bismuth	1.80 0.80
Do	1	Latent Wassermann. Has congenital syphilitic children	4	—	3	4	3	4	3	—	2	4	2	3	Neoarsph Bismuth	4.80 1.40

Case H–30276. Patient, seen May 5, 1928, complains of severe headaches at menstrual periods and sore throat. No clinical evidence of lues. One year before patient had miscarriage (in the third month).

May 12, 1928, spinal fluid Wassermann 4–4 (1 cubic centimeter and 0.4 cubic centimeter of fluid). Colloidal mastic test, 2221000000.

Patient started treatment (arsphenamine, neoarsphenamine and bismuth) May 1928.

November 5, 1928, Wassermann blood Neg. Neg., Kahn 1.

Influence of treatment upon the Kahn and Wassermann tests.— The influence of treatment upon the Kahn and Wassermann tests was studied in 25 cases, which received weekly intravenous injections of arsphenamine and neoarsphenamine. Bismuth was also used in cases with secondary and tertiary manifestations of the disease. In Table 12, we selected 11 cases that were fair representations of the different varieties of syphilis. The results showed that the Kahn precipitation test remains positive longer in patients under the influence of various treatments than either of the complement-fixation reactions. Therefore, in the presence of a known case of syphilis, a negative Kahn test will have perhaps a greater diagnostic value than the Wassermann methods.

SUMMARY AND CONCLUSIONS

Two hundred twenty cases were studied under clinical control and comparisons were made between the Kahn and the Wassermann tests. The water-bath and the ice-box methods with a sensitive antigen were used in the Wassermann reaction, and the latter method was found the more delicate of the two. The technic employed in the Kahn test was the latter method, proposed by its author. The results seem to agree in general with those obtained by other investigators in regard to the sensitiveness of the Kahn test. In the few nonsyphilitic cases examined no false results have been observed, and in the syphilitic cases, the Kahn test has consistently appeared more pronounced especially in latent syphilis, and in cases under the influence of treatment, as compared with the Wassermann ice-box fixation method. Compared with the ordinary water-bath method, the Kahn test is undoubtedly very much more sensitive. We feel, therefore, that the Kahn reaction when properly done and properly interpreted is a valuable test for the serological diagnosis of syphilis and should be used in routine work in conjunction with the Wassermann reaction, particularly when the water-bath method is the only method used. It will give the physician a more dependable laboratory diagnosis than the Wassermann water bath alone could give.

ACKNOWLEDGMENT

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262412——6

COMPARATIVE SEROLOGIC STUDY OF VERNES, WASSERMANN, AND KAHN REACTIONS IN EXPERIMENTAL TREPONEMATOSES

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In the course of the investigations performed by Dr. Otto Schöbl(1) and his collaborators on experimental yaws and syphilis in Philippine monkeys, hundreds of these animals were inoculated with yaws, syphilis, or both.

Through the courtesy of these investigators, I was permitted to utilize the blood of some of these experimental animals for the purpose of studying the sensitiveness of the Vernes method, as compared with the Wassermann and Kahn methods, and of determining whether or not the Vernes reaction gives regular results in yaws- or syphilis-infected Philippine monkeys.

MATERIAL INVESTIGATED

For the information of the reader the following data must be mentioned:

1. The blood of twenty-one infected Philippine monkeys was examined and reported for this paper. The majority of these animals had been inoculated within the last five years.
2. The strains of *Treponema pertenue* were secured by direct inoculation from patients in the Philippines to monkeys, and were maintained alive through successive passages in monkeys.
3. The strain of *Treponema pallidum* used in these monkeys was the well-known laboratory strain known as "Nichols strain."
4. Some of these monkeys had received some intramuscular injections of neosalvarsan in the past, and a few had received injections of heated antitreponematous vaccines.
5. In this investigation ten normal Philippine monkeys were tested as controls. The blood of these normal animals invariably gave negative results with the Vernes, Wassermann, and Kahn tests.

TECHNIC

During this investigation the Wassermann and Kahn tests were performed by Dr. Onofre Garcia, of the biologic division, Bureau of Science, on the day following the bleeding of the animals. The technic for the Wassermann test was the same as that described previously by Dr. Otto Schöbl and the writer; (2) that is, guinea pig's complement, antimonkey hæmolytic system, and cholesterinized antigen.

The technic followed in performing the precipitation test is the standard method of Kahn.(3)

The samples of blood for the Vernes test were received by the present author at irregular intervals, and the Vernes reaction was performed with the sera at periods of from two to ten days after the bleeding of the animals.

The Vernes reaction was performed by following exactly Professor Vernes's technic, which the author of this paper learned in the laboratory of Professor Vernes, at the Prophylactic Institute of Paris, during his last trip to France in the autumn of 1929.

The results of the Wassermann and Kahn tests are as follows:

Very strongly positive	++++ (100 per cent hæmolysis).
Strongly positive	+++ (75 per cent hæmolysis).
Moderately positive	++ (25 per cent hæmolysis).
Slightly positive	+ (10 per cent hæmolysis).
Very slightly positive (doubtful)	± (5 per cent hæmolysis).
Negative	— (no hæmolysis).

The results of the Vernes reaction in our tables are given in figures that exactly represent the numbers of the photometric readings of each sample of blood. In this way, and following the advice of Professor Vernes, misinterpretations were avoided in the results of the Vernes reaction when compared with the nomenclature generally adopted in the readings of the Wassermann and Kahn tests.

Since the Vernes method gives to the clinician a more quantitative measurement of the treponematous infection in the patient than either the Wassermann or the Kahn test, because the reading in the first test is made by means of a photometer, the table adopted by Vernes for the clinical interpretation of these figures is also given here.

The following table is based on a great number of clinical and serologic studies of normal and syphilitic patients.

SYPHILIMETRIC TABLE

Photometric reading –0. This means a completely normal serum.

Photometric reading 1–2. This means a normal serum, although somewhat doubtful.

Photometric reading 3–4. In 100 normal sera, there were only 2 sera that gave the values 3–4. In 100 sera taken at random approximately 25 syphilitic sera were found which gave the values 3 and 4. The formula is $\frac{25-3}{75 \times N}$.

Photometric reading 5–6. In 500 normal sera, only one serum gave the values 5–6. In 100 sera taken at random approximately 50 syphilitic and 50 non-syphilitic sera gave the values 5 and 6. The formula is $\frac{50-3}{50 \times N}$.

Photometric reading 7, 8, 9, 10, 11. In 2,000 sera there were approximately 1.999 syphilitic sera and only one non-syphilitic serum. The formula is $\frac{1.999-S}{1-N}$.

Photometric reading 12, 13, 14, 15, 16, 17, 18. In 10,000 sera there were 9.999 syphilitic sera and only one non-syphilitic serum. The formula is $\frac{9.999-S}{1-N}$.

Photometric reading 19, 20, 21, 22, 23, 24, 25, 26, 27. In 650,000 sera there were approximately 649.999 syphilitic sera and only one non-syphilitic serum. The formula is $\frac{649.999-S}{1-N}$.

Values higher than the photometric reading 27. Indicate syphilitic infection without exception. The formula is S — sure.

Taking into consideration the results obtained with the Wassermann reaction, our twenty-one sera examined here were classified as follows:

	Number of sera.
Slightly positive +	7
Moderately positive (++)	2
Strongly positive (+++) and (++++)	12
Total	21

RESULTS OF TESTS

The results of the tests presented in Table 1 show that the Vernes method follows the results of the Wassermann test more closely than those of the Kahn test, with the exception of monkey 12, and that in the slight reactions the Vernes test gives more definite and clear-cut results than the Wassermann test itself. In regard to the Kahn test, Vernes reaction is also more sensitive in the slight reactions.

TABLE 1.—*Showing the results of the blood in seven infected Philippine monkeys.*

Monkey.		Test.				
Number.	Designation.	Wassermann.	Kahn.	Date performed.	Vernes.	Date performed.
6	Yac–10	+	++	7– 1–30	4	7–11–30
7	Sy–D–20	+	+	7– 7–30	10	7–11–30
8	F–38	+	±	7– 7–30	11	7–11–30
9	Ym–20 no clip	+	+	7–23–30	6	7–29–30
10	L–13 right	+	—	7–23–30	5	7–29–30
11	Sy–3	+	±	6–24–30	10	6–26–30
12	K–28	+	+	7– 9–30	0	7–13–30

Table 2 shows the results of the tests of two moderately positive sera. The Vernes reaction here also seems to be more sensitive than the Wassermann, more especially in monkey 13, and more sensitive than the Kahn test in monkey 14.

TABLE 2.—*Showing the results of the tests in two moderately positive sera.*

Monkey.		Test.				
Number.	Designation.	Wassermann.	Kahn.	Date performed.	Vernes.	Date performed.
13	L–15 cut tail	++	+++	7–23–30	22	7–29–30
14	W–23	++	±	11– 4–30	7	9–11–30

TABLE 3.—*Showing the results of the Vernes, Wassermann, and Kahn tests in strongly positive sera from infected Philippine monkeys.*

Monkey.		Test.				
Number.	Designation.	Wassermann.	Kahn.	Date performed.	Vernes.	Date performed.
15	Yac–12	++++	++++	7– 1–30	94	7–11–30
16	B–9	++++	++++	7– 1–30	60	7–11–30
17	E–14–instr. tail	++++	++++	7– 7–30	62	7–11–30
18	O–C both clip	++++	—	7–24–30	32	7–29–30
19	Sy–P–23	++++	—	7–24–30	49	7–29–30
20	K–13–left	++++	+	7–24–30	76	7–29–30
21	Yaw–V–10	++++	++++	6–20–30	91	6–26–30
22	F–2	++++	++++	8– 6–30	67	8–13–30
23	J–1	++++	++	8– 6–30	89	8–13–30
24	G–25	++++	++++	8– 8–30	136	8–13–30
25	J–11	++++	++	10–30–30	25	11– 4–30
25	W–25	+++	++	11– 4–30	14	11–11–30

Table 3 shows the results with strongly positive sera from twelve infected Philippine monkeys. The Vernes reaction follows again more closely the results of the Wassermann rather than the Kahn test and gives a better measure of the amount of the treponematous "reagin" in vivo.

SUMMARY

The blood of twenty-one Philippine monkeys infected at different intervals of time with yaws, syphilis, or both, have been tested. A few of these animals received neosalvarsan treatments in the past and also injections of heated antitreponematous vaccines.

The results of the Vernes, Wassermann, and Kahn tests agree in a general way, but the Vernes reaction follows more closely the results of the Wassermann test in spite of the fact that the Vernes reaction was performed a long time after the bleeding of the animals. This circumstance necessarily will bear some influence on the results and the sensitiveness of the test. Nevertheless, in our series the Vernes test is found somewhat more sensitive than our Wassermann test.

Since the readings of the Vernes test are made by means of a photometer and the results are expressed in figures, a more accurate quantitative measurement of the "reagin" is made possible. The results, therefore, are more helpful especially for the clinical interpretation of weakly positive and border line results for which the reading of the Wassermann and Kahn tests are usually insufficient.

It must be borne in mind that the precipitation reactions in Philippine monkeys give much lower results than the Wassermann test, as proven by Doctors Schöbl and Garcia with the Kahn test. Nevertheless the Vernes reaction, being a precipitation reaction, gives higher values, or did in our experiments, than both the Wassermann and Kahn tests.

CONCLUSIONS

1. In Philippine monkeys inoculated with yaws or syphilis, the Vernes reaction was found regularly positive.
2. This fact shows the sensitiveness of the reaction of Vernes, which is a precipitation reaction. It is known that precipitation reactions (Kahn) are not as pronounced in Philippine yaws or syphilitic monkeys as the Wassermann test.

3. This is particularly evident in sera with a low and a moderate degree of positive reaction (Table 1), whether compared with Wassermann or Kahn reaction.

4. Sera from infected Philippine monkeys giving high positive values with Wassermann reaction likewise give high values with Vernes reaction, unlike those with Kahn.

5. With regard to Philippine monkeys the Vernes reaction seems to have an advantage over both the Wassermann and Kahn tests.

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MALARIA TRANSMISSION IN THE PHILIPPINES, IV

METEOROLOGICAL FACTORS [1]

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THREE TEXT FIGURES

Mayne, [2] in his article on the influence of relative humidity on the presence of malarial parasites in the insect carrier, mentions the work of Bentley on the influence of temperature and humidity on the malaria incidence of Bombay between 1909 and 1911, which brought to light a definite relationship between the months of heaviest infections and the phenomenon of relative humidity. Bentley found that the occurrence of new infections coincided with a period of slightly lower but not more uniform high temperature in the presence of increased humidity. Mayne's work covered dissection of 5,052 mosquitoes from March to September, 1927, in the District of Saharanpur, United Provinces, India. Out of this number, he found five infected *A. calicifacies*—Giles (total number of this species, 2021) collected from August 9 till September 8, a period with the highest relative humidity (82 to 99 per cent). Gill,[3] in his epidemiological methods of forecasting seasonal appearance of endemic or epidemic malaria in Punjab, India, uses biological as well as meteorological factors. Wenyon [4] believes that in the natural infection of mosquitoes, temperature is a much more important factor than humidity. He asserts that there is no evidence that the effects of humidity of the atmosphere play any part in the active development of parasites to the mosquitoes. "Provided there is sufficient moisture in the air to enable the mosquito to live, the malarial parasites will develop normally." He agrees with

[1] From the field laboratory, division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan. The writer expresses here his gratitude to Father Miguel Selga, director of the Weather Bureau, for his personal interest, valuable suggestions, loan and installation of instruments, and training of the laboratory personnel in making observations.

[2] Indian Journ. Med. Res. **15** (1928) 1073.

[3] Cited from Mayne.

[4] Cited from Mayne.

Gill that the spread of malaria may, however, be affected by lack of humidity, but only on biological grounds, because the mosquitoes which ingest parasites may not live long enough for sporozoites to appear in the salivary glands. In Europe (North Holland)[5] malaria in mosquitoes is prevalent in autumn and winter with its maximum in November or December, while malaria in man is a phenomenon of spring and summer with its maximum in June or July. Swellengrebel (p. 25) says:

> The fact that in two localities so near each other as Nieuwendam and Wormerveer or Sloten, there is no synchronism in the epidemic periodicity (beginning of epidemic in Nieuwendam in 1912 with remission in 1914–1917, at Wormerveer beginning of epidemic in 1918, at Sloten in 1921) makes it doubtful whether climatic conditions can have much influence. On the other hand, the synchronous decline of the epidemic in 1923 indicated the presence of a common inhibiting factor. Was this factor the low temperature of the fourth quarter of 1922 and the first and second quarters of 1923? If so, why did the epidemic cease at Wormerveer after 1902 and why did it show a remission in Nieuwendam? Have the dryness and high temperature anything to do with it; if so, why did not the climate in 1911 produce a similar effect? (The following year witnessed an exacerbation of epidemic at Nieuwendam.)
>
> These considerations make it impossible to attribute any epidemiological importance in the climatic changes observed here, the more so as no influence can be detected on the anopheline population.

Granting that the epidemics were diagnosed correctly, Swellengrebel's conclusions are to be expected but his data are subject to further analysis, for, (1) to expect synchronism in the epidemics between 1912 and 1921 in the three nearby places due to a common cause (climate) several variable factors, as the mosquito density, the number of suitable human carriers, and their accessibility to the mosquito, including those of the susceptibles, should be equally present in all. (2) The introduction of a new parasite strain in one place and not in the others should be considered. On the other hand, the synchronous decline of malaria in 1923 cannot be explained by such variable factors as coincident decrease in the number of suitable carriers, immunity, treatment of cases, mosquito control, improved living conditions, etc., all happening at the same time in the three places, all the more so when the campaign in these places from 1920 to 1923 was limited to mosquito control measures, and at Nieuwendam, this work was confined to catching adults in the stables only (pp. 31-35). Since

[5] Principles and Methods of Antimalarial Measures in Europe:2d general report of the Malaria Commission, League of Nations (1927) 61. Malaria in the Kingdom of the Netherlands (1927) 67–70, graphs 4 and 5.

climatic records are available from 1902 to 1923, while the anopheles data are only available for the years 1920 to 1923, the rôle of the transmitter under the existing climatic conditions in the incidence of malaria from 1902 to 1919, inclusive, is not known. The trend of the disease during this period cannot and should not be explained on the basis of the mosquito findings from 1920 to 1923 alone. It would seem, therefore, that in the synchronous decline of the epidemic in 1923, with a parallel trend of the disease from 1921 to 1923 in the three places mentioned, (graph 5, p. 70) while no climatic influence was detected on the anopheline population, one cannot eliminate entirely a common inhibiting factor (the low temperatures in the fourth quarter of 1922 and the first and second quarters of 1923). Neither can the influence of the climate on the behaviors of the disease and on the mosquitoes previous to 1920 be ignored because anopheles and human carrier data are not available or have not been utilized.

One point is indisputable in Swellengrebel's observations, and that is the coincidence of malaria in mosquitoes with the months of high relative humidity (see his table 4*a*, p. 45 and graph 6, p. 71).

The results of two years (September, 1927, to August, 1929) systematic captures and dissections for natural malaria infection of *A. funestus* Giles in two adjacent camps of La Mesa and South Portal of the Novaliches water project,[6] form the basis of the present article. Meteorological records were taken from the field laboratory at Tungkong Manga, 9 to 10 kilometers north of La Mesa and South Portal but at about the same elevation (100 meters) above sea level. Unfortunately, these observations were not carried on simultaneously with the mosquito observations, but were from September, 1929, to August, 1930, and may differ from those obtaining from September, 1927, to August, 1929. The average monthly rain gauge readings from September, 1927, to August, 1929, at La Mesa, however, show the same proportionate distribution as those from September, 1929, to August, 1930, at Tungkong Manga, although somewhat lower. Any difference in temperature and relative humidity between the two periods at the two places would probably be a difference in degree only and not in distribution. The use of meteorological data for September, 1929, to August, 1930, therefore, seems justified and should give at least a relative value.

[6] See the preceding three papers.

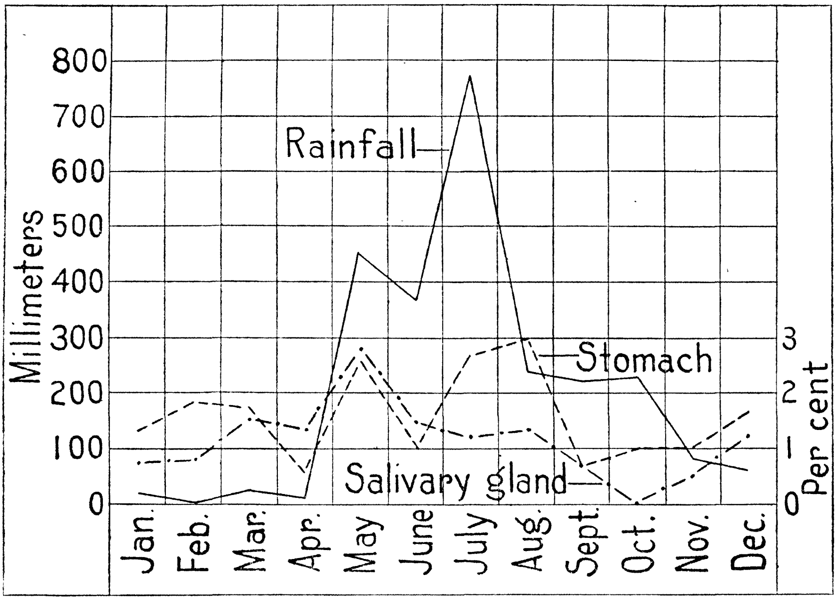

FIG. 1. Showing a rise of the rates of infection in *Anopheles funestus* during the period of heaviest rain although the infections were also present during the dry months.

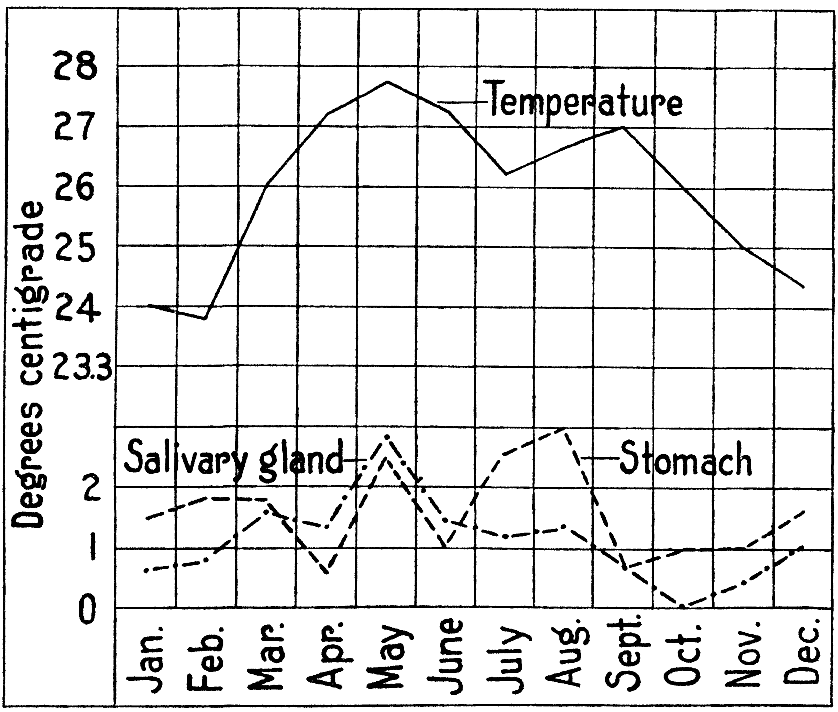

FIG. 2. Showing a rise of the rates of infection in *Anopheles funestus* during the warmest months although they were also present during the cool months.

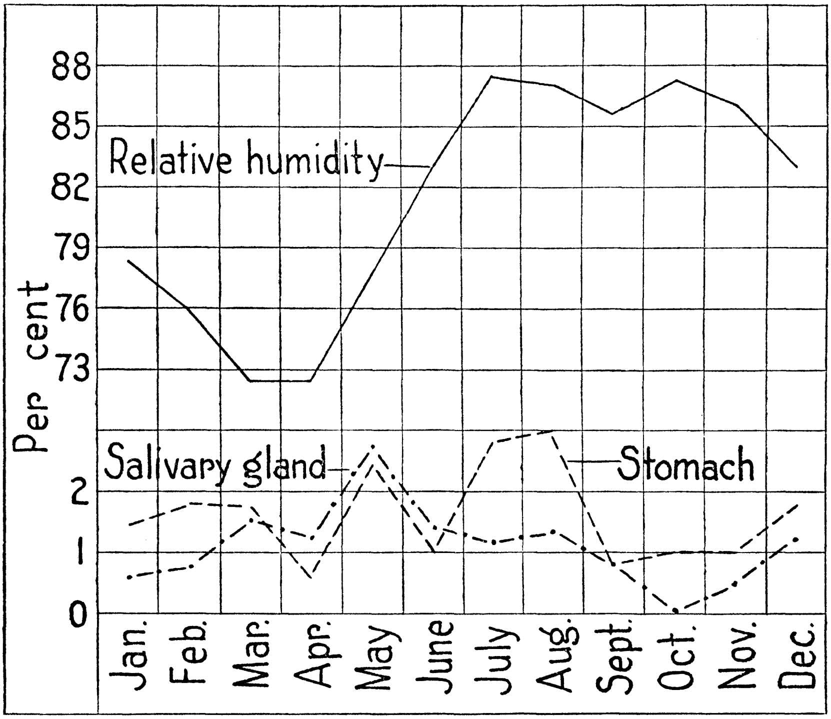

FIG. 3. Showing some rise in the rates of infection in *Anopheles funestus* during the months of high relative humidity although they were also present in March and April, months with the lowest percentage of relative humidity.

TABLE 1.—*Dissection of funestus from La Mesa and South Portal.*

Month.	Number dissected.	Positive stomachs.	Per cent.	Positive salivary glands.	Per cent.
January	932	11	1.2	8	0.8
February	327	6	1.8	3	0.9
March	878	15	1.7	14	1.6
April	668	4	0.6	9	1.3
May	686	18	2.6	19	2.8
June	782	8	1.0	11	1.4
July	883	23	2.6	10	1.1
August	571	17	3.0	7	1.2
September	1,058	8	0.7	8	0.7
October	1,190	12	1.0	2	0.1
November	767	8	1.0	4	0.5
December	803	14	1.7	9	1.1

Table 1 shows the monthly catches and infections found during the period of observation. The influence of larval control on the adult density and uncontrolled movements and quininization of

TABLE 2.—*Meteorological observations at Tungkong Manga.*

Month.	Rainfall.						Temperature.						Relative humidity and vapor tension.			
	6 a. m.		2 p. m.		Total, 24 hours.		6 a. m.		2 p. m.		Minimum.	Maximum.	6 a. m.		2 p. m.	
							Dry.	Wet.	Dry.	Wet.			R. H.	V. T.	R. H.	V. T.
	in.	*mm.*	*in.*	*mm.*	*in.*	*mm.*										
January	0.15	3.9	0.39	9.9	0.54	13.8	18.7	18.2	29.0	23.5	17.7	30.4	95	15.3	62	18.3
February	.0	.0	.0	.0	.0	.0	17.6	17.0	29.9	23.7	16.4	31.4	95	14.2	57	18.0
March	.602	15.4	.10	2.5	.702	17.9	19.4	18.7	31.9	24.4	18.5	33.6	93	15.6	52	18.0
April	.051	1.3	.314	8.0	.369	9.3	20.9	20.1	32.2	25.0	19.8	34.5	90	17.1	55	19.1
May	10.070	246.0	7.841	199.2	17.911	455.2	23.4	22.5	31.3	25.5	22.4	33.2	92	19.8	63	20.6
June	9.175	233.4	5.036	127.9	14.211	361.3	23.4	22.8	29.8	26.4	22.7	31.9	95	20.3	71	21.8
July	19.644	499.1	10.749	273.0	30.393	772.1	24.4	23.8	28.0	25.4	23.2	29.2	94	21.4	81	22.4
August	5.977	151.8	3.555	90.4	9.532	242.2	23.6	23.1	28.0	25.9	22.9	30.5	96	20.8	78.5	22.3
September	2.371	60.2	2.912	73.9	5.283	210.0	22.9	22.4	29.8	26.7	22.3	31.7	95	19.8	76	23.4
October	4.75	119.9	3.926	99.7	8.656	218.6	22.4	22.06	28.2	25.2	22.12	29.98	96	19.5	78	22.0
November	2.442	62.1	1.289	32.8	3.731	94.9	21.2	20.96	28.0	24.7	20.7	29.4	97	18.39	75	21.19
December	2.018	51.2	.497	12.7	2.515	63.9	19.6	19.2	28.5	24.2	19.2	29.7	96	16.1	69	19.3

the population on mosquito infection are not known. Temperature shows no apparent influence on breeding and adult density in this locality.

Table 2 shows the monthly mean meteorological observations.

COMMENTS

Given a favorable adult *funestus* density, a community of the topography of South Portal with a low rate of suitable human carriers would be expected to have a seasonal prevalence of malaria coinciding with the months of most rainfall, high mean temperature and relative humidity. Areas where the *funestus* breeding streams dry out during the dry months, would be expected to have malaria during the rainy season. On the other hand, localities where the breeding is limited to permanent streams, heavy rains would flush the larvae, reduce the density and transmission even in the presence of suitable carriers. Since *funestus* has been found infected in nature in all months of the year provided suitable carriers are available, the observed prevalence of malaria during the rainy season in one region and dry season in another, may be explained by the influence of the rain on the amount of breeding and the resultant adult density of the transmitter. Both types of breeding, permanent and temporary streams, exist in the Novaliches water project, as previously mentioned,[7] and explains the uniform high *funestus* density observed in the camps in 1927 and 1928. The natural decline in *funestus* density observed in South Portal in 1929 and 1930, and in North Portal and Tungkong Manga in 1929, (the former dropping in February, the latter in May) cannot be explained.[8]

SUMMARY

1. From the available mosquito data at the La Mesa and South Portal camps of the Novaliches water and meteorological data at the field laboratory in Tungkong Manga, malarial infection in *A. funestus* Giles shows a rise in the rates with the increase of rainfall, mean temperature and relative humidity, although infections were also present during the dry, cool, and less humid months.

2. *Anopheles funestus* breeds in permanent or temporary streams and the influence of the rainy season on breeding and the resultant adult density probably explains the different seasonal distribution of malaria transmission in the Philippines.

[7] Manalang, Philip. Journ. Sci. 37 (1928) 123.

[8] See preceding article.

ILLUSTRATIONS

TEXT FIGURES

LEAF AND SEED STRUCTURE OF A PHILIPPINE CORIARIA

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FOUR PLATES

This rare shrub, a species of *Coriaria*, occurs in the Mountain Province, northern Luzon, and is the only species recorded in the Philippines under the small family *Coriariaceæ*. It is botanically known as *Coriaria intermedia* Matsumura. For a number of years this plant has been a subject for research on account of the reputed poisonous properties of its leaves and seeds. Chemical and toxological investigations have been made and at present a still more extensive research on the same line is being conducted. Very interesting results have already been obtained. This critical study of the structure of the leaf and seed of the Philippine *Coriaria* was undertaken, therefore, with a view to having a definite basis for the identification of fragments of the plant in cases of poisoning. Then, too, it was thought that this plant, being rare in this country, might show some structure useful to the systematic anatomy of the Phanerogams.

The late Eduardo Lete, pharmacist from San Fernando, La Union, was the first to report the poisonous properties of Philippine *Coriaria* to the Bureau of Science about the year 1915. During the summer of 1916, while the writer was detailed in Benguet by the Bureau of Science to collect some botanical specimens, he obtained direct information from some of the natives in Trinidad valley, Baguio, concerning the poisonous effects on man of this plant, commonly known by them as *buakat*, or *backet*. He was told that at one time a certain couple with their two children died of poisoning after taking a decoction of the fruits and leaves of *buakat* or *backet*, which they mistook for their native Benguet tea, because of the similarity of the two plants. In the summer of 1918, a year later, the writer was assigned to conduct a more extensive botanical exploration in Haight's Place and vicinity, about 60 miles north of Baguio. He collected several kilos of the fruits and shoots of Philippine

Coriaria and from this material attempts to isolate its active principle and to conduct experiments showing its action upon animals were made by the chemists of the Bureau of Science. In 1919, Wells(7) reported that *Coriaria intermedia* contains a poisonous glucoside in its leaves and fruits.

Lindsay(2) claims that in New Zealand there are at least three species of *Coriaria;* among them is *Coriaria ruscifolia* Linnæus, the most abundant and popularly known as toot-poison because of its poisonous properties. The action of the poisonous portions of this plant on man, cattle, and on sheep were described by him respectively. He indicated that toot-poison belongs to the class narcotico irritants.

Among the known species of *Coriaria,* the only one that has been thoroughly investigated is *Coriaria myrtifolia* Linnæus. This species is found distributed in the southern part of France, Spain, and Italy. According to Reutter(5) it contains a glucoside called coriamyrtin and an alkaloid coriarine, also a considerable amount of tannin and resinous substances. Its important anatomical features described by Solereder(6) may be summarized as follows: (*a*) The stomata occur on both surfaces of the leaf and they are adjoined on either side by a single subsidiary cell, parallel to the pore; (*b*) the upper and lower epidermal cells in surface view are polygonal in outline; (*c*) the leaf tissue is nearly centric and almost entirely formed by palisade tissue; (*d*) the outer limit of the bast is formed by massive isolated groups of bast fibers; (*e*) the medullary rays are broad and are as much as seven cells in breadth, and the medullary cells are elongated in a vertical direction; and (*f*) the end-walls of the vessels have simple perforations and the wood parenchyma has simple pits.

Recently Kariyone and Sato(1) reported that *Coriaria japonica* A. Gray, contains coriamyrtin, similar to the one isolated from *Coriaria myrtifolia.*

MATERIAL AND METHODS

The seeds and leaves used for this study were collected by the author last summer from plants growing in the city of Baguio and along the trail leading to Mount Santo Tomas. The fruits and leaves were preserved in 6 per cent solution of formalin. The study of the flowers was made from the dry specimen kept in the Bureau of Science and from the fresh material that was generously sent to the writer by Mr. Sixto Laraya, District Forester, stationed at Baguio.

The seeds are very minute and enclosed by a very hard pericarp, which serves as seed coat and makes sectioning quite difficult. This difficulty was remedied, however, by embedding them in a thick paste of gum arabic, which was subsequently exposed at room temperature until the consistency of the gum was suitable for sectioning. Several free-hand sections were made by using a gillette blade. The cross section through the blade was prepared by means of a sliding microtome, stained with safranin and contrasted with Delafield's hæmatoxylin and mounted in balsam.

DESCRIPTION

The plant.—This shrub was first described by J. Matsumura (3) from the specimen collected from Formosa as follows:

Coriaria intermedia, Matsumura, sp. nov. Frutex polygamo-monoicus, foliorum forma et magnitudine C. Japonicae, A. Gray, similis, antheris verruculosis, carpellis, versus latus reticulatis inter C. myrtifoliam, L. et C. nepalensem, Wall. mediatus. Racemi quam eas C. Japonicae, A. Gray. breviores, 50–90 mm. longi, aphylli, vel foliati. Sepala ovalia, margine purpures suffusa. Fl. steril. petala minutissima; stamina 10; antheris oblongo-ellipticis, verruculosis; vestigio germino mullo. Fl. fem; petala sepalis multo breviora, oblonga, acuta, intus carinata, stamina 10; carpella 5, petalis paulo breviora, matura vix 4 mm. longa, dosali unicostata, versus latus ventrale prominente venosa.

As to the identity of the Philippine *Coriaria*, Merrill(4) reported the following:

LUZON, Province of Benguet, Suyoc to Paui, (*4800 Merrill*), Nov. 7, 1905. In ravines at about 2,000 m. Formosa.

Specimens of the above number were sent to Dr. J. Matsumura of the Botanical Institute, Imperial University, Tokyo, Japan, for comparison with the type of his Formosan species, and after comparing the specimens, he expresses the opinion that the Luzon plant is identical with his *Coriaria intermedia*. Specimens collected in Benguet by Vidal, and recorded by him as "C. sp. (aff. *C. Japonica* A. Gray)" are undoubtedly referable to *Coriaria intermedia* Matsum. The thirteen known species of the genus have a peculiar geographical distribution extending from the Mediterranean region to the mountains of British India, Japan and Formosa and from New Guinea to New Zealand, Mexico and South America. The presence of this Formosan species in Benguet adds another very characteristic species to the known northern element in the Philippine flora.

The *Coriaria* from the Philippines as observed by the writer has the following features. It is a shrub from 1 to 3 meters high. The young branches are quadrangular and of a reddish or pinkish color with slightly elevated boatshaped lenticels. The leaves are from 2 to 4.2 centimeters in width and from 4 to 8.5 centimeters in length (Plate 1, fig. 1). They are sim-

ple, ovate-lanceolate, trinerved, glabrous and short petiolate with entire margin. The upper surface is dark green and the lower surface is light green or sometimes yellowish-green. The base varies from obtuse to rounded and the apex is acute or sometimes acuminate. The petiole is very short, from 1 to 2 millimeters long, nearly cylindrical with a shallow groove in the upper part. The midrib is prominently projecting on the lower side, at the base of which or directly from the upper end of the petiole two primary veins arise, one on each side, extended toward and close along the margin of the leaf and converging toward the apex. The flowers are arranged in simple racemes, from 6 to 15 centimeters long and they are provided with bracts (Plate 1, figs. 2, 3, and Plate 4, fig. 33 *a-c*). They are polygomo-monoecious, very minute, measuring about two millimeters in length, and are greenish in color tending to reddish or purplish coloring at the margin of the sepals, or appearing entirely red. The calyx consists of five persistent ovate sepals, concave in the inner part with acute or acuminate apex, two of which are slightly smaller in size; the petals are also five ovate, very minute, persistent, cream-white in color, with a prominent angular projection on the inner side (Plate 1, figs. 5, 8). During the maturation of the fruit, these petals develop unusually fast. They cover the cocci and become fleshy and are of a reddish color turning finally to bluish black, as represented on Plate 1, figures 10 and 14. The andrœcium of the sterile flower consists of 10 stamens, and that of the bisexual flower varies from 5 to 10. The anthers of the fully developed male flowers are oblong, verrucous, quadrilocular, introrse and purplish or reddish in color with long filaments (Plate 1, figs. 7, 9). They measure about 2.2 millimeters in length. The anthers of the bisexual flower vary from ovate to oblong-ovate or oblong, and usually are much smaller and have shorter filaments than those of the normal male flower. They measure from 0.7 millimeter to 1 millimeter in length (Plate 1, figs. 4 to 6, 8, 10, and 15). The gynæcium is composed of five more or less independent pistils, with filamentous reddish or purplish stigmas covered with papillose appendages (Plate 1, figs. 5, 8, 10). The fruit is composed of five very small crustaceous cocci, surrounded by fleshy persistent petals and sepals of a bluish-black color, which makes it berrylike in appearance (Plate 1, figs. 10, 13, and 14).

Structure of the leaf.—The transverse section of the leaf of Philippine *Coriaria* is bifacial. The blade is nearly uniform,

measuring about 0.25 millimeter. The upper epidermis is composed of a single layer of flattened or rectangular cells with very thick and highly cutinized outer cell walls. The lower epidermis also consists of a layer of cells of the same shape as the upper epidermal cells, but they are slightly thinner, their outer walls are less cutinized and some of them are modified into guard cells. The mesophyll is differentiated into palisade and spongy regions. The palisade chlorenchyma occupies about one-third of the mesophyll and consists of two layers of tubular cells arranged perpendicularly with distinct intercellular spaces. The palisade cells of the upper layer are longer than those of the lower one. They measure about 0.05 millimeter in length, whereas the lower palisade cells measure only about 0.03 millimeter. The spongy chlorenchyma region is made of parenchyma cells of various forms and sizes, but most are slightly elongated in the direction parallel to the surface of the leaf. It is richly supplied with air spaces. Plate 3, fig. 30, represents a transverse section through the midrib showing the character of the mesophyll described above. Calcium oxalate crystals and epidermal outgrowth are wanting.

In the surface section, the upper epidermal cells are polygonal in outline with from 5 to 7 straight thick walls. They are from 0.02 to 0.04 millimeter in length and from 0.015 to 0.03 millimeter in width and they are characterized by a fine, wavy striation that runs either parallel to the longer side of the epidermal walls or obliquely to the longest side of the epidermal wall. Plate 3, figure 31, is a small portion of the section prepared from the upper epidermis showing the surface view of the epidermal cells with the characteristic striations of their cuticle. Unlike the upper epidermis of *Coriaria myrtifolia* the stomata are wanting in the upper epidermis. The surface view of the lower epidermal cells is represented on the same plate, figure 32. The lower epidermal cells are also polygonal in outline measuring from 0.015 to 0.045 millimeter in length and from 0.01 to 0.03 millimeter in width, and are characterized by fine striations but their walls are thinner and vary from four to seven in number. The stomata are somewhat characteristic and numerous. They are not uniform in size and vary from 0.025 to 0.028 millimeter in length and from 0.012 to 0.015 millimeter in width. They are usually surrounded by four neighboring cells. Two of these neighboring cells limit the upper and lower ends of the stomata while the other two limit

the lateral sides and are applied parallel to the length of the guard cells. The first two are larger in size than the others.

The midrib is convex above and strongly convex below. The upper epidermis as well as the lower one consists of a single layer of cells, rectangular, or barrel-shaped, or nearly square in outline (Plate 3, fig. 30). The outer cell walls of the upper epidermis of the midrib as well as those of the upper epidermis of the blade are comparatively thicker than those of the lower epidermis. The collenchyma cells are poorly developed and as usual are found in two regions, one just in the inner side of the upper epidermis above the meristele and the other located within the lower epidermis below the meristele. The chlorenchyma cells in the upper region, as well as those of the lower region, consist of 3 to 4 layers of cells with more or less uniformly and slightly thickened walls. The cortical parenchyma located between the meristele and the lower collenchyma is composed of 4 to 6 layers of large polygonal isodiametric thin-walled cells, while the cortical parenchyma found in the inner part of the upper collenchyma region consists of three to seven layers of small polygonal thin-walled parenchyma cells.

The endodermis is somewhat conspicuous. It consists of a single layer of rectangular, square or polygonal, thin-walled parenchyma cells. Within this endodermis, the meristele is located. It is more or less lenticular in shape and the conducting tissue is somewhat plano-convex in outline. The upper part as well as the lower part is bounded by two groups of poorly developed sclerenchymatous cells. The walls of these cells are not much thickened nor highly lignified. The xylem region is limited on both the upper and lower part (nearly surrounded) by small and not distinctly differentiated phloem cells. It is made up mostly of xylem vessels, from 0.01 to 0.02 millimeter in diameter and wood parenchyma.

The seed.—The seed is campylotropous, exalbuminous and inclosed by a hard pericarp. It is kidney-shaped, laterally compressed, more rounded on one margin and the apex narrowly rounded (Plate 1, fig. 17 *a–c*). It measures from 2.2 to 3.2 millimeters in length, 1.6 to 2 millimeters in breadth and 1.2 to 1.5 millimeters in thickness. Externally it is brown in color and its surface is characterized by one prominent dorsal angular elevation or riblike structure that extends from the upper end of the hilum or micropylar to its lower or chalazal end, and two to four elevations or ribs on each lateral or flattened side. These ribs run parallel to the dorsal one and they are more or less

concentric to the hilum. They sometimes anastomose each other by a few transverse elevations that connect one with the other. The hilum is somewhat arrow-shaped with the narrow end toward the apex. The pericarp is hard, cutinized, and lignified. It takes the place of the outer seed coat or testa. The seed coat proper is only one and is very thin. The embryo is slightly bent and whitish in color. The hypocotil is short, conical, and measures about 0.4 to 0.6 millimeter in length. The cotyledons are fleshy, plano-convex, and sometimes they are slightly unequal in size. The plumule is inconspicuous.

Microscopical structure.—A diagrammatic representation of the transverse section of the coccus of *Coriaria intermedia* drawn under the camera lucida is indicated in Plate 1, fig. 18, showing the pericarp, the seed coat and a pair of cotyledons. The section is ovate in outline with a prominent angular protuberance at the upper part corresponding to the principal rib extended along the dorsal side of the coccus, it is more or less convoluted on the ventral side, corresponding to the section of the hilum, and is irregularly crenate or wavy on the lateral sides. The pericarp is differentiated distinctly into two regions, namely, the parenchymatous region and the stony region. The parenchymatous region corresponds to the exocarp and is made up of several layers of irregularly shaped parenchyma cells with slightly suberized cell walls which usually contain a brownish substance. In the outer part it is limited by a single layer of thick-walled cutinized and somewhat rectangular epidermal cells. The stony region is differentiated into two parts. The outer part, which corresponds to the mesocarp, is built up of obliquely or tangentially arranged elongated stone cells with very thick, lignified, and pitted cell walls. This portion is more definite on the lateral sides in which tangentially elongated sclerenchymatous elements conspicuously run parallel to the inner surface of the pericarp. The sclerenchymatous cells of the same region toward the dorsal sides, however, are mostly arranged obliquely, following the outline of the outer surface of the pericarp. At the region where the elevations or ribs, indicated above, are located groups of greatly elongated sclerenchymatous cells are observed. These sclerenchymatous cells in cross section appear polygonal in outline with from five to eight thick, lignified, and pitted cell walls with very much reduced cell cavity. They measure from 0.3 to 0.4 millimeter in length. The inner portion of this stony region, corresponding to the endocarp of a fleshy fruit, consists of radially elongated polygonal stone

cells with greatly thickened and highly lignified cell walls and with very much reduced cavities. Their walls are not distinctly striated. Plate 2, figs. 20, 21, and 22, show three different portions of the transverse section of the pericarp. In fig. 20, the sclerenchymatous tissue found in the region corresponding to the rounded elevation or rib is indicated and the stone cells of the middle portion of the stony region are seen tangentially elongated. Figure 21 shows a portion close to the dorsal region of the coccus, and fig. 22 illustrates the arrangement of the stone cells, which are found on the flattened sides of the pericarp.

The seed coat measures about 0.65 millimeter in thickness. In the outer part it is limited by a single layer of thin-walled empty parenchyma cells with a more or less rectangular outline. Their outer walls are wavy and brownish in color. In the surface view these cells appear polygonal in outline with wavy cell walls. Sometimes they are slightly elongated and their walls vary from four to six. Plate 2, fig. 24, shows a transverse section of the seed coat while fig. 25 on the same plate illustrates the characteristics of the surface view of the outer layer of cells of the seed coat. The inner part of the seed coat consists mostly of obliterated or considerably flattened parenchyma cells. Owing to the compactness of these cells their individual characteristic cannot be determined. These flattened cells are differentiated into two groups or regions. The walls of the cells in the outer region are brownish in color, while those in the inner region are colorless and hyaline. These two regions are sometimes separated by a row of tangentially elongated parenchyma cells with thin walls. Boat-shaped structures filled with protoplasm are often observed among the obliterated parenchyma cells in the innermost part of the seed coat.

The cotyledons in transverse section are plano-convex in outline. They are built up entirely of thin-walled parenchyma cells filled with aleurone grains or protein granules. In the outer part, they are surrounded by single thin-walled parenchyma cells of rectangular, barrel-shaped or polygonal outlines. The peripheral portion is occupied largely by radially elongated thin-walled parenchyma cells, and the middle portion by polygonal parenchyma cells. Plate 3, fig. 28, represents a segment taken from the convex or dorsal side of a cotyledon, showing the slightly elongated parenchyma cells. Figure 18, on same plate, illustrates a segment taken from the ventral or flat side of a cotyledon. This portion shows a greater elongation in the parenchyma on the inner side. In the tangential section, these

parenchyma cells appear more or less isodiametric in characteristic and they are polygonal in outline, as indicated on Plate 3, fig. 27. Plate 2, fig. 26, represents a median section of a cotyledon cut parallel to its flat surface showing a group of small elongated parenchyma cells, which initiate the formation of the conducting tissue.

When the seeds are subjected to Schultz's maceration process, the conspicuous type of cell observed under the microscope is indicated on Plate 2, fig. 23, *a* and *b*. The stone cells derived from the stony region display a great diversity of forms and sizes. They vary from 0.01 to 0.06 millimeter in length. They are either elliptical ovate, oblong, elongated, tapering at both ends, straight or bent at one side, crooked or irregularly shaped cells. Their walls are prominently pitted but not distinctly striated and their cavities are very much reduced. The long sclerenchymatous elements are numerous, and they are either straight or crooked and taper at both ends.

SUMMARY

1. The leaf in cross section is bifacial. The upper and lower epidermis consist of a single layer of cells with very thick and highly cutinized outer cell walls. The mesophyll is thin and composed of two rows of palisade chlorenchyma in the upper part and spongy chlorenchyma in the lower part.

2. The stomata are located on the lower surface only and are characterized by the parallel arrangement of the two small subsidiary cells to the pore. Epidermal outgrowth and calcium oxalate are wanting.

3. In the surface preparation, both the upper and the lower epidermal cells are polygonal in outline with fine wavy striations.

4. The midrib in cross section exhibits poorly developed collenchyma and sclerenchymatous cells. The endodermis is distinct and the phloem cells are found surrounding the water conducting tissue.

5. The seed is campylotropous, exalbuminous and inclosed by the adhering pericarp. Externally, it is brown to dark brown in color and characterized by the presence of riblike structure elevations found at the dorsal and lateral sides.

6. The pericarp is hard and differentiated into two regions; namely, the parenchymatous region and the stony region. The seed coat is only one and very thin.

7. The embryo is small, slightly bent, and whitish in color. The hypocotil is short and conical. The cotyledons are plano-convex in outline, consisting of thin-walled parenchyma cells richly supplied with protein granules and the plumule is inconspicuous.

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ILLUSTRATIONS

[The microscopical drawings and sketches of some of the flowers were prepared by the author, except figs. 20 and 30 which were drawn by Miss Teodora Kalalo, assistant instructor, Department of Botany, University of the Philippines. The habit sketches, including the sketches of some of the flowers, fruit, and seeds, are by Mr. Macario Ligaya, Bureau of Science.]

PLATE 1. CORIARIA INTERMEDIA MATSUMURA

FIG. 1. A small portion of the plant showing the arrangement and character of the leaves and fruit; × 0.5.
2. A raceme of young bisexual flowers showing the bracts and their characteristic filamentous stigma; × 2.5.
3. A portion of a receme of young male or sterile flowers; × 3.
4. A single bisexual flower after fertilization; × 8.
5. A young bisexual flower partially dissected to show the relative position between sepals *s*, petals *p*, the pistil and the stamen drawn from a fresh flower; × 8.
6. A single bisexual flower showing the relative positions of the stamens and stigmas; × 8.
7. A fully developed male flower with ten stamens with long filaments, *s*, sepals, and *p*, petals; × 8.
8. A longitudinal floral diagram of a young bisexual flower showing the relative position between the sepals, petals, and pistils.
9. A young male or sterile flower showing the arrangement of the anthers; × 8.
10. A semi-diagrammatic drawing of a mature bisexual flower. *s*, sepals, *p*, petals.
11. A floral diagram of the cross section of a sterile or male flower.
12. A floral diagram of the cross section of a bisexual or perfect flower.
13. A semi-diagrammatic drawing of a cross section of a nearly mature fruit, *s*, sepals, and *p*, petals.
14. A mature fruit; × 2.5.
15. *a–e*, A group of anthers dissected from a bisexual flower; × 12.
16. Normal stamens from a male flower. *a*, ventral view and *b*, dorsal view; × 12.
17. The mature coccus drawn in three positions, *a*, dorsal side, *b*, lateral side, and *c*, ventral side; × 6.
18. A diagrammatic representation of the transverse section of a coccus. *scl*, sclerenchyma, *p*, parenchyma, and *co*, cotyledon and *h*, xylem; × 16.
19. A lateral view of the embryo with one cotyledon removed. *r*, radicle, and *co*, cotyledon; × 16.

PLATE 2. CORIARIA INTERMEDIA MATSUMURA

FIG. 20. A segment of the transverse section of the pericarp taken from the lateral part near the region of a rib. *scl*, sclerenchyma, *sc*, stone cells, and *p*, parenchyma; × 275.

21. Another segment of a transverse section from the lateral part of the pericarp, *e*, epidermis, *p*, parenchyma, *scl*, sclerenchyma, *sc*, stone cells; × 275.
22. A segment of the transverse section near the dorsal side of the pericarp showing the greatly tangentially arranged sclerenchyma cells, *scl*; and the stone cells, *sc*; ×275.
23. A group of isolated cells from the pericarp, *a*, sclerenchyma cells, × 165; and *b*, stone cells; × 450.
24. A segment of a transverse section of the seed coat. *op*, outer obliterated parenchyma with brown coloration. op_2, obliterated parenchyma without brown colorations; × 275.
25. A segment of the surface view of the outer part of the seed coat; × 275.
26. A longitudinal section of the cotyledon showing the elongated parenchyma cells, which initiate the development of the conducting tissue; × 275.

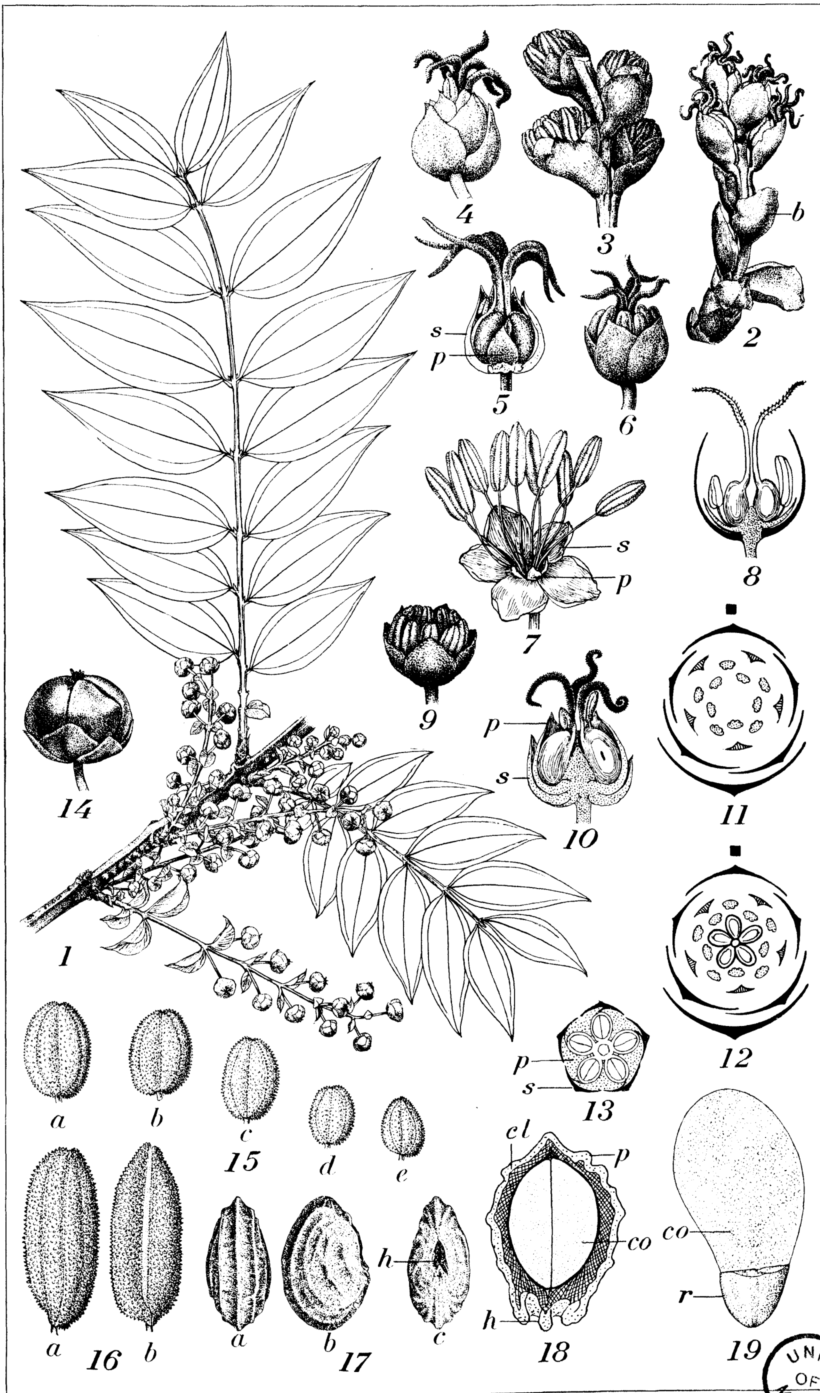
PLATE 3. CORIARIA INTERMEDIA MATSUMURA

FIG. 27. A tangential section of the cotyledon showing the polygonal outline of the parenchyma cells containing protein granules; × 275.

28. A segment of the transverse section of the cotyledon through the dorsal side showing the epidermis and the slight radial elongation of the parenchyma cells containing protein granules; × 275.
29. A transverse section of the cotyledon through the ventral side showing the radial elongation of the parenchyma cells containing protein granules; × 275.
30. A transverse section of a leaf through the midrib. *c*, collenchyma, *en*, endodermis, *scl*, sclerenchyma, *ph*, phloëm, and *x*, xylem; × 125.
31. A segment of the surface preparation of the upper epidermis showing a fine striation; × 450.
32. A surface view of a segment prepared from the lower epidermis showing the stomata and the characteristic fine striation of the cuticle; × 450.

PLATE 4. CORIARIA INTERMEDIA MATSUMURA

FIG. 33, *a–c*. Photograph of the portions of the fresh leafless branches showing the arrangement of unisexual and bisexual flowers.


4
3
b
2
s
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8
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PLATE 1.

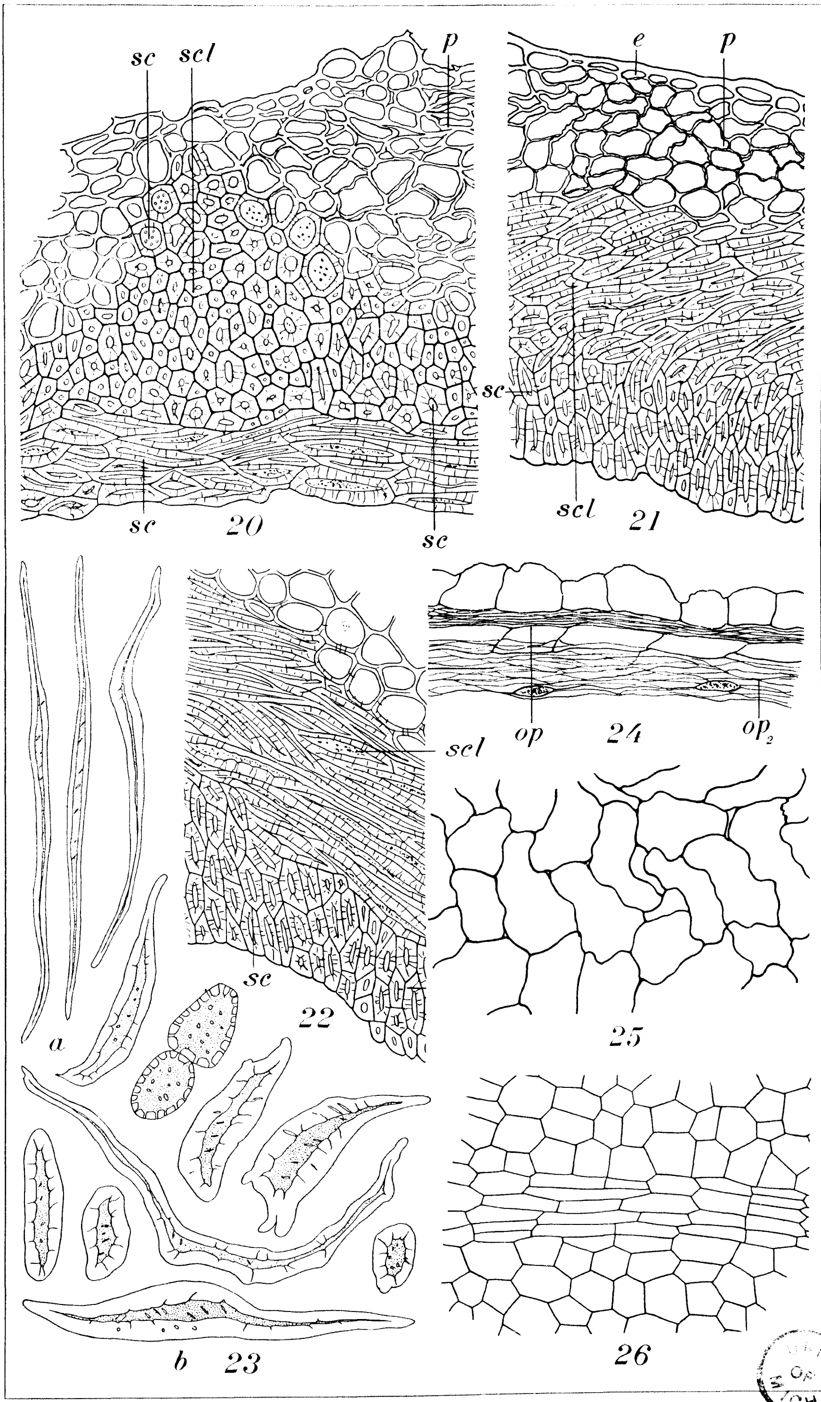

PLATE 2.

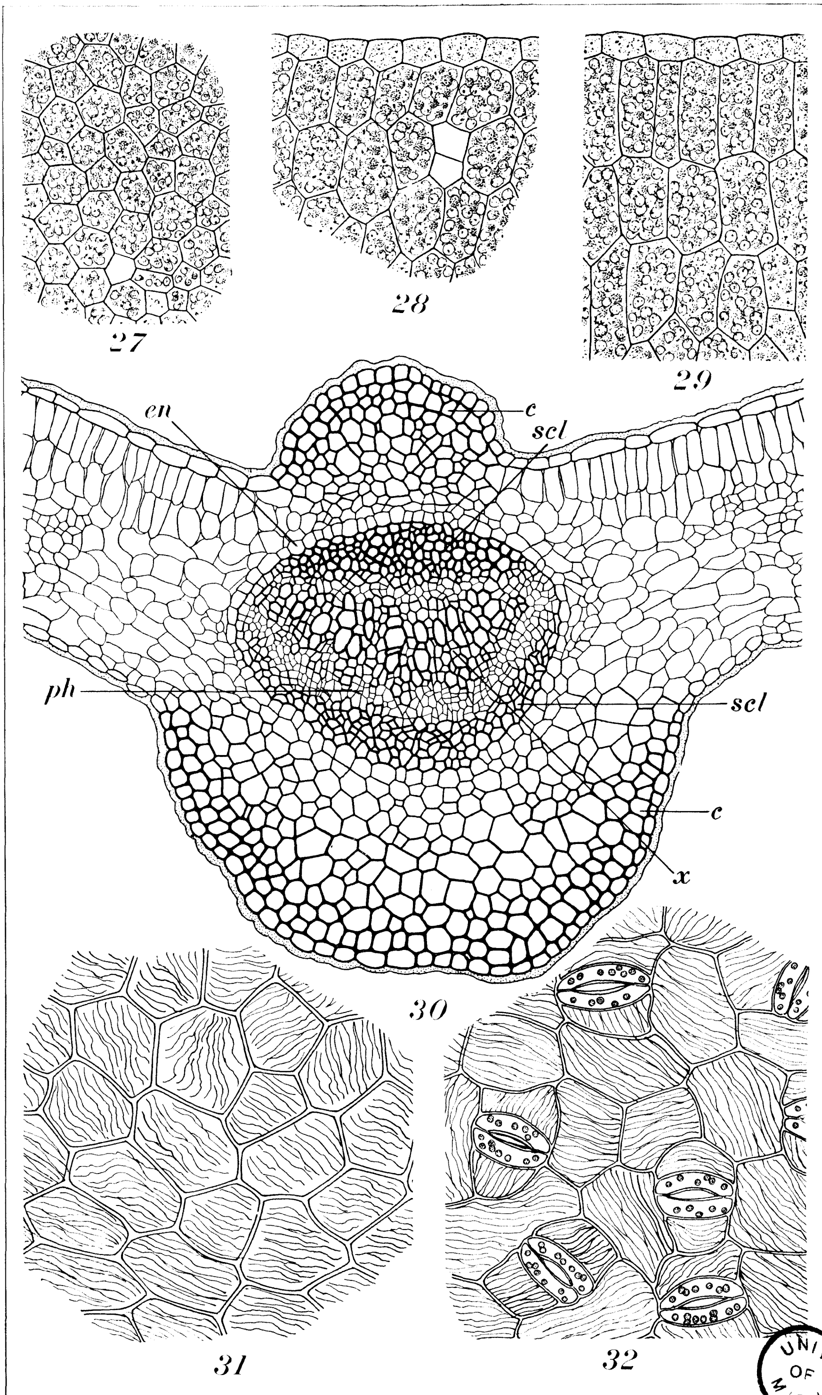

PLATE 3.

PLATE 4.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), XI[1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The very interesting crane flies discussed herewith were taken in various parts of Luzon by my friends Messrs. McGregor, Duyag, and Rivera, and in Minadanao by my former student at this college Mr. Charles F. Clagg. I wish to thank these gentlemen for their continued kindly interest in making known this fauna.

TIPULINÆ

Genus DOLICHOPEZA Curtis

Dolichopeza CURTIS, Brit. Entomol. (1825) 62.

I must consider several groups that are allied to *Dolichopeza* and have hitherto been maintained as distinct genera as representing no more than subgeneric aggregations. Such subgenera are as follows:

Dolichopeza, s. s., is found in the western Palæarctic and eastern Nearctic Regions, with the vast majority of the species occurring in Australia and New Zealand. Curiously enough, with the above distribution, no species is found in the Chilean Subregion of the Neotropics. A few aberrant species that may be found to be incorrectly placed herein, including *isolata* Alexander (Luzon), are found in the Oriental and Ethiopian Regions.

Nesopeza Alexander is the dominant subgenus in the Oriental and eastern Palæarctic Regions. The typical group (*gracilis* and allies) has Rs very long and the wings handsomely patterned. Edwards is inclined to restrict the subgeneric name to this latter group, leaving the equally or more abundant species with plain wings and Rs of a shorter length in the typical subgenus.

[1] Contribution from the entomological laboratory, Massachusetts Agricultural College.

Mitopeza Edwards includes five species, of which one is described herewith from Luzon. All the known species are from the Oriental Region. The typical form, having macrotrichia in the distal cells of the wing, with very blunt unchitinized cerci, and with a very remarkable condition of the spermothecal ducts in the female, is very distinct. However, *longicornis* Brunetti lacks the macrotrichia and has the spermothecal ducts reduced in number and size. This reduction is carried still further in *rizalensis* sp. nov. The Bornean *mjöbergi* Edwards has a very distinct and peculiar venation (Plate 1, fig. 4).

Oropeza Needham has about a score of species that are nearly evenly distributed in the eastern Nearctic and eastern Palæarctic Regions.

Trichodolichopeza Alexander, as known, is entirely Ethiopian, with the majority of the species occurring in South Africa.

Megistomastix Alexander is represented only by two species in the Greater Antilles of the Neotropical Region.

These subgeneric groups may be separated by means of the following key:

1. Apical cells of wings with macrotrichia .... 2.
   Apical cells of wing without macrotrichia .... 4.
2. Cell 1st M_2 closed .... 3.
   Cell 1st M_2 open by atrophy of basal section of M_3.
   Trichodolichopeza Alexander.
3. Rs short, transverse, not exceeding one-half R_{2+3}; Sc_2 ending opposite origin of Rs; m-cu connecting with M_{3+4} at or close to fork, always beyond the fork of M .... *Megistomastix* Alexander.
   Rs long, exceeding one-half R_{2+3}, Sc_2 nearly opposite its fork; m-cu connecting with M far before its fork, at the fork in *nigromaculata* Edwards .... *Mitopeza* Edwards (in part) (*nitidirostris* et al.).
4. Cell 1st M_2 closed .... 5.
   Cell 1st M_2 open by atrophy of basal section of M_3 .... 6.
5. Rs short, Sc_2 ending opposite or just beyond its origin; m-cu beyond fork of M .... *Oropeza* Needham.
   Rs long, subequal to or nearly as long as R_{2+3} Sc_2 ending nearly opposite its fork; m-cu far before fork of M.
   Mitopeza Edwards (in part) (*longicornis*).
6. Rs short, transverse, Sc_2 opposite or close to its origin.
   Dolichopeza Curtis.
   Rs longer, subequal to or longer than R_{2+3}, Sc_2 ending beyond midlength .... 7.
7. Branches of medial field regularly pectinate, r-m connecting posteriorly with the basal section of M_{1+2} (Plate 1, fig. 3) .... *Nesopeza* Alexander.
   Branches of medial field not pectinate, r-m connecting with M_1 some distance beyond origin (Plate 1, fig. 4).
   Mitopeza Edwards (in part) (*mjöbergi*).

Scamboneura Osten Sacken might also be construed as falling within the limits of *Dolichopeza,* but I would believe that it represents a separate branch of the Dolichopezaria.

DOLICHOPEZA (MITOPEZA) RIZALENSIS sp. nov. Plate 1, fig. 1; Plate 2, fig. 23.

General coloration dark brown; legs with the tips of the tibiæ and all tarsi snowy white; wings grayish subhyaline, with a heavy dark brown pattern in the costal and apical portions; sparse macrotrichia in cells of wing at apex.

Male.—Length, about 8 millimeters; wing, 10.5; antenna, about 4.5.

Female.—Length, about 9 millimeters; wing, 10 to 11.

Rostrum brownish yellow; palpi black. Antennæ (male) a little more than one-half the length of body; basal segments testaceous, beyond the first flagellar passing into black; flagellar segments long-cylindrical, with a delicate erect pubescence and a group of three or four relatively short verticils at base on outer face of segments, these much shorter than the segments alone. Head blackish, sparsely pruinose behind on sides, the front yellowish.

Mesonotal præscutum dark brown, with indications of four dark reddish brown stripes; posterior sclerites of mesonotum more uniformly brown. Pleura testaceous brown. Halteres elongate, dark brown, the extreme base of stem pale yellow. Legs with the coxæ and trochanters testaceous yellow; femora dark brown, paler basally; tibiæ brown at base, the tips narrowly snowy white; tarsi snowy white. In the male the tibiæ are chiefly white, the basal third more darkened. Wings (Plate 1, fig. 1) grayish subhyaline, heavily patterned in costal and apical portions with dark brown; cells C and Sc dark, the bases paler; radial field heavily darkened, especially in female, with conspicuous whitish spots before and beyond the stigma; cord and veins beyond it seamed with brown. Sparse macrotrichia in outer ends of cells R_3 to 2d M_2, inclusive. Venation: Rs subequal to or longer than R_{2+3}; cell 1st M_2 relatively small.

Abdominal segments chiefly blackened, especially on posterior portion, the base laterally brightening to obscure yellow; hypopygium dark. Male hypopygium (Plate 2, fig. 23) with the tergite, *9t,* trifid, the pale cushionlike median lobe projecting caudad beyond the level of the laterals, densely clothed with microscopic erect setulæ; lateral lobes with less numerous coarse setæ. Outer dististlyle, *od,* profoundly bifid. Inner dististyle, *id,* very irregular in outline.

Ovipositor with blunt fleshy lobes; spermothecal ducts relatively few.

LUZON, Rizal Province, Novaliches, August 8 and 9, 1930 (*A. C. Duyag*); holotype, male; allotype, female; paratypes, 1 male and 1 female.

Dolichopeza (*Mitopeza*) *rizalensis* agrees with the subgenotype, *D.* (*M.*) *nitidirostris* (Edwards), and the more recently described *D.* (*M.*) *nigromaculata* (Edwards) in the presence of macrotrichia of the apical cells of the wing, differing from both in the snowy-white tarsi and tibial apices. In the latter character, the present species agrees with *D.* (*M.*) *longicornis* (Brunetti), which differs in having no macrotrichia in apical cells of wing and with the male antennæ longer than the entire body. The following key will suffice to separate the known species of *Mitopeza:*

1. Cell 1st M_2 open by the atrophy of the basal section of M_3 (Borneo). *mjöbergi* (Edwards).
   Cell 1st M_2 closed .... 2.
2. Apical cells of wing without macrotrichia (Assam). *longicornis* (Brunetti).
   Distinct though sparse macrotrichia in apical cells of wing........ 3.
3. Legs black .... 4.
   Legs with the tarsi and tips of tibiæ extensively whitened (Luzon). *rizalensis* sp. nov.
4. Head blackish; præscutum with four velvety-black spots, one pair in humeral region, the other before the wings; m-cu at fork of M (Perak) .... *nigromaculata* (Edwards).
   Head dark brown; thorax dark brown, the præscutum with indications of three darker stripes; m-cu far before fork of M (Kedah). *nitidirostris* (Edwards).

DOLICHOPEZA (NESOPEZA) MELANOSTERNA sp. nov. Plate 1, fig. 2; Plate 2, fig. 24.

Male.—Length, about 8 to 9 millimeters; wing, 9.5 to 11.

Female.—Length, about 11 millimeters; wing, 11.

Generally similar and allied to *D.* (*N.*) *angustaxillaris* Alexander (Luzon), differing especially in the larger size, details of venation, as the deeper forks of M, the much darker coloration, including the entirely blackened eighth sternite, and the structure of the male hypopygium, especially the ninth tergite.

Antennæ longer than in *angustaxillaris,* the flagellar segments correspondingly lengthened. Mesonotum dark brown, the pleura pale, the dorsopleural region darkened; ventral sternopleurite, meron, and anepisternum with darkened areas. Legs with the white proximal ends of fore basitarsi narrow, of the mid basitarsi obsolete or with a mere genual brightening. Wings

(Plate 1, fig. 2) strongly tinged with blackish; medial forks deep. Abdominal tergites chiefly blackened, with a narrow transverse yellow annulus on basal half; hypopygium black, including the entire eighth sternite. Male hypopygium (Plate 2, fig. 24) with the tergite, *9t,* blackened, the lateral lobes broad, simple, their ventral margins heavily blackened and microscopically toothed; median lobe small, acute. Outer dististyle, *od,* shorter and stouter than in *angustaxillaris.*

LUZON, Laguna Province, Ube, February 3 to 12, 1930 (*F. Rivera*); holotype, male; allotype, female; paratypes, 8 males.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) BILOBULIFERA sp. nov. Plate 1, fig. 5; Plate 2, fig. 25.

General coloration pale ocherous, with a conspicuous black dorsal stripe on pleura; knobs of halteres infuscated; legs chiefly yellow, the femoral tips insensibly darkened; wings whitish subhyaline, the small stigma circular in outline; cell 1st M_2 long; male hypopygium with the outer dististyle a small, hairy, bilobed structure; inner style with the body small, produced into a long ribbonlike portion.

Male.—Length, about 4.2 to 4.4 millimeters; wing, 5 to 5.3.

Rostrum reddish brown; palpi a little darker. Antennæ black, the outer segments paling to brown; relatively elongate for a member of this genus, if bent backward extending nearly to the wing root; flagellar segments passing through oval to cylindrical, the verticils of the outer segments shorter than the segments alone; terminal segment elongate, about one-half longer than the penultimate. Head blackish, sparsely pruinose; eyes (male) contiguous on vertex or nearly so, the ommatidia coarse.

Mesonotum pale ocherous, scarcely variegated with darker, the scutellum and median area of scutum more testaceous. Pleura pale yellow, with a broad blackish dorsolongitudinal stripe. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters yellow; femora yellow, the tips insensibly darker; tibiæ and tarsi obscure yellow, the terminal tarsal segments infuscated; claws elongate, with a long conspicuous spine at near one-third the length. Wings (Plate 1, fig. 5) whitish subhyaline, the prearcular and costal regions more yellowish; stigma brown, circular; veins dark brown, paler in the flavous areas. Venation: Sc_1 ending about opposite two-thirds the length of the long arcuated Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 unusually long, the second

section of M_{1+2} being equal to the third section; basal section of M_3 longer than m, gently arcuated; m-cu at fork of M; vein 2d A at origin converging toward 1st A, the cell relatively long and narrow.

Abdominal segments bicolorous, dark brown, the caudal margins of the individual segments narrowly obscure yellow; hypopygium chiefly yellow, the basistyles conspicuously dark brown. Male hypopygium (Plate 2, fig. 25) with the basistyles, *b*, covered with short dense setulæ, in addition to scattered major setæ; ventromesal lobe, *b*, large, flattened, basal in position, weakly bilobed at apex. Two dististyles, the outer, *dd*, a small, unequally bilobed hairy structure; inner style, *vd*, with the base a trifle enlarged, thence long-produced into a slender blade, the inner margin before midlength with a small pale spinous point. Gonapophyses, *g*, with the mesal-apical lobe elongate, slender, transversely ribbed.

LUZON, Laguna Province, Ube, February 3, 1930 (*F. Rivera*); holotype, male; paratype, male.

Limonia (*Limonia*) *bilobulifera* is very different from the other regional species in the structure of the male hypopygium.

LIMONIA (LIMONIA) MELANOPLEURA sp. nov. Plate 1, fig. 6; Plate 2, fig. 26.

General coloration brownish black, including most of the thoracic pleura; halteres and legs brownish black; claws simple; wings with a strong blackish tinge, the circular stigma darker; Sc_1 ending about opposite midlength Rs, Sc_2 at its tip; male hypopygium with the ventromesal lobe of basistyle very large and stout; ventral dististyle small, setiferous, produced into a long slender rostral prolongation, without spines.

Male.—Length, about 3.5 millimeters; wing, 4.2.

Female.—Length, about 5 millimeters; wing, 4.8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments (male) oval, the longest verticils slightly exceeding the segments and unilaterally arranged; the female has the segments short-oval. Head black, sparsely pruinose; eyes of both sexes contiguous or nearly so, at most separated by a capillary strip of anterior vertex.

Mesonotum brownish black. Pleura chiefly black, the ventral sternopleurite and dorsopleural region paler, testaceous brown. Halteres brownish black, the extreme base of stem pale. Legs with the coxæ brownish testaceous, the trochanters somewhat paler; remainder of legs brownish black; claws small, without distinct spines. Wings (Plate 1, fig. 6) with a strong

blackish tinge, the circular stigma darker brown; veins dark brown. Venation: Sc_1 ending about opposite midlength of Rs, Sc_2 at its tip; free tip of Sc_2 slightly proximad of R_2; m-cu just before the fork of M; vein 2d A long, converging toward 1st A at origin.

Abdomen, including the hypopygium, black. Male hypopygium (Plate 2, fig. 26) with the tergite, *9t*, unusually extensive, broad at base, strongly narrowed outwardly, the two low lobes separated by a small emargination; a submarginal series of about six strong setæ on either side. Basistyle, *b*, relatively long and slender, the ventromesal lobe very stout, occupying almost the entire mesal face of the style. Ventral dististyle, *vd*, a small oval lobe with long conspicuous setæ, the rostral prolongation long, slender, only gently curved, with no developed spines.

LUZON, Laguna Province, Ube, April 14, 1930 (*R. C. McGregor*); holotype, male; allotype, female.

Limonia (*Limonia*) *melanopleura* is well-distinguished by the small size, very extensive black coloration, and the structure of the male hypopygium. I cannot indicate any closely allied regional species.

LIMONIA (LIMONIA) TREMULA sp. nov. Plate 1, fig. 7.

General coloration of mesonotal præscutum brown, variegated with sublateral and a posterior median yellow stripe; pleura yellow, with a conspicuous longitudinal dark stripe; halteres dusky; legs yellow; wings grayish yellow, with a restricted brown pattern; Rs angulated and weakly spurred at origin; m-cu about one-half its length beyond the fork of M; abdomen brownish black, the segments narrowly ringed caudally with yellow.

Female.—Length, about 5.5 millimeters; wing, 6.3.

Mouth parts small, the rostrum reddish brown; palpi black. Antennæ black throughout; basal flagellar segments subglobular to short-oval, the outer segments more elongate; segments with two conspicuous verticils on outer face, unilaterally arranged. Head fulvous brown, the center of the vertex extensively darkened.

Pronotum brown. Mesonotal præscutum brown, variegated with brownish yellow, the latter including sublateral stripes that meet in front and a median stripe on posterior half of sclerite; the darkened portions include the lateral margins to the anterior region and submedian stripes that become approximated in front, behind crossing the suture onto the scutal lobes; median region

of scutum and scutellum obscure yellow, the latter with each lateral third darkened; postnotal mediotergite testaceous brown, more yellowish laterally and on the dorsal half of the pleurotergite. Pleura obscure yellow, with a conspicuous dorsolongitudinal dark stripe that extends to the abdomen, including the ventral half of the pleurotergite; ventral sternopleurite a little darkened. Halteres dusky, the base of stem restrictedly pale. Legs with the coxæ yellow, the fore coxæ a trifle darkened; trochanters yellow; remainder of legs obscure yellow, the femoral tips rather broadly but insensibly clearer yellow; terminal tarsal segments a trifle darkened; claws relatively slender, with a basal tooth that is further prolonged into a slender seta. Wings (Plate 1, fig. 7) grayish yellow, with a restricted and relatively diffuse brown pattern, including the stigma, cord, and outer end of cell 1st M_2; origin of Rs and fork of Sc; basal portion of wing and costal region a little darkened; veins cream-colored, a little darkened in the clouded areas. Macrotrichia of veins relatively long and conspicuous, including Rs except on its basal section. Venation: Sc_1 ending about opposite three-fifths the length of Rs, Sc_2 at its tip; Rs angulated and weakly spurred at origin; free tip of Sc_2 and R_2 in approximate transverse alignment; cell 1st M_2 large, subrectangular, a little longer than vein M_3 beyond it; m-cu about one-half its length beyond the fork of M, subequal to the distal section of Cu_1; vein 2d A strongly sinuous, at origin parallel to vein 1st A or nearly so.

Abdomen brownish black, the segments narrowly ringed caudally with yellow; genital segments ocherous. Ovipositor with the tergal valves slender, gently upcurved, reddish horn color; sternal valves large, straight, conspicuously blackened at base.

LUZON, Laguna Province, Ube, February, 1930 (*F. Rivera*); holotype, female.

Limonia (*Limonia*) *tremula* is amply distinct from described regional species, agreeing in some respects with *L.* (*L.*) *luteivittata* Alexander, but differing in all details of coloration and venation.

LIMONIA (LIBNOTES) UNISTRIOLATA sp. nov. Plate 1, fig. 8; Plate 2, fig. 27.

General coloration of mesonotal præscutum obscure yellow, with a single complete black stripe, on either side behind bordered by clear golden yellow; rostrum, palpi, antennæ, knobs of halteres and legs black; wings with a faint brown suffusion; Sc_1 long; Rs angulated at origin; cell 1st M_2 small, rectangular, less than one-half the distal section of M_{1+2}; anal veins gently diver-

gent; male hypopygium with the ventral dististyle large and fleshy, the rostral prolongation with two very unequal spines.

Male.—Length, about 6 millimeters; wing, 6.8.

Female.—Length, about 6.3 millimeters; wing, 7.

Rostrum and palpi black. Antennæ black throughout; flagellar segments subcylindrical, becoming longer outwardly; verticils of basal segments slightly exceeding the segments; terminal segment pointed at apex, about one-half longer than the penultimate. Head black, sparsely pruinose, the anterior vertex more silvery, reduced to a narrow strip.

Pronotum black, the anterior lateral pretergites yellow. Mesonotal præscutum obscure yellow, with a single broad and complete black stripe, on either side on posterior two-thirds clear golden yellow; lateral portions of sclerite weakly infumed; scutal lobes black; median region of scutum paler; scutellum and postnotal mediotergite blackened. Pleura chiefly brown, the posterior dorsopleural region and the ventral sternopleurite obscure yellow. Halteres pale, the knobs dark brown. Legs with the fore coxæ infuscated, the remaining coxæ and all trochanters yellow; remainder of legs dark brown, only the femoral bases restrictedly pale. Wings (Plate 1, fig. 8) with a faint brown suffusion, the circular stigma a trifle darker; veins pale brown. Venation: Sc_1 ending opposite r-m, Sc_2 far from its tip, Sc_2 about opposite midlength of the angulated Rs; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 relatively small, less than half the distal section of vein M_{1+2}; m and basal section of M_3 subequal, straight, in approximate transverse alignment; m-cu at one-third the length of cell 1st M_2; anal veins parallel to gently divergent at origin.

Abdomen dark brown, the sternites obscure yellow; hypopygium dark. Male hypopygium (Plate 2, fig. 27) with the tergite, *9t*, extensive, the caudal margin with a deep V-shaped notch, the lateral lobes with coarse setæ. Basistyle, *b*, relatively small. Ventral dististyle, *vd*, a large fleshy lobe, the rostral prolongation with two unequal gently curved spines. Dorsal dististyle a strongly curved hook, the tip acute. Gonapophyses, *g*, with the concave margin of the mesal-apical lobe with minute points.

LUZON, Mountain Province, Ifugao Subprovince, Huungduan, April 5, 1930 (*F. Rivera*); holotype, male; allotype, female.

Allied to species such as *L.* (*L.*) *neofamiliaris* Alexander and *L.* (*L.*) *subfamiliaris* Alexander, likewise from Luzon, differing conspicuously in the coloration and details of structure of the male hypopygium.

LIMONIA (LIBNOTES) MELANCHOLICA sp. nov. Plate 1, fig. 9; Plate 2, fig. 28.

General coloration polished black; rostrum, palpi, antennæ, knobs of halteres, and legs blackened; wings with a faint dusky tinge, cells C and Sc darker; Sc_1 ending some distance beyond r-m, Sc_2 opposite the fork of Rs; cell 1st M_2 rectangular, less than one-half vein M_{1+2} beyond it; m and basal section of M_3 in nearly transverse alignment; m-cu at about one-fourth to one-fifth the length of cell 1st M_2; anal veins gently divergent; male hypopygium with the ventral dististyle large and fleshy, the rostral prolongation with two straight spines of unequal diameter.

Male.—Length, about 5.5 to 7 millimeters; wing, 6 to 7.

Female.—Length, about 6.5 to 6.8 millimeters; wing, 6.5.

Rostrum, palpi, and antennæ black; flagellar segments oval, becoming more elongate outwardly; longest verticils exceeding the segments in length and unilaterally arranged. Head black, heavily dark gray pruinose; anterior vertex narrow, light gray.

Pronotum black. Mesonotum polished black, the median region of scutum obscure yellow. Pleura chiefly black, the propleura, dorsal pteropleurite, and dorsopleural membrane brownish yellow. Halteres yellow, the knobs dark brown. Legs with the fore and hind coxæ yellow, the mid-coxæ slightly darkened; all trochanters yellow; remainder of legs brownish black, the femoral bases restrictedly pale; claws relatively long and slender, with an acute subbasal tooth, with additional microscopic basal denticles. Wings (Plate 1, fig. 9) with a faint dusky tinge, cells C and Sc more infumed; wing tip and posterior margin to vein Cu slightly clouded; a dark seam along vein Cu; stigma subcircular in outline, slightly darker than the ground color; veins dark brown. Venation: Sc_1 ending some distance beyond r-m, Sc_2 opposite the fork of Rs, Sc_1 a little longer than m-cu; free tip of Sc_2 and R_2 in approximate transverse alignment; cell 1st M_2 rectangular, less than one-half vein M_{1+2} beyond it; m and basal section of M_3 in nearly transverse alignment; m-cu at from one-fourth to one-fifth the length of cell 1st M_2; anal veins gently divergent.

Abdomen black, the sternites brown; genitalia of both sexes darkened. Male hypopygium (Plate 2, fig. 28) with the caudal emargination of the tergite, *9t*, broadly V-shaped; marginal setæ of lobes strong and powerful; a group of about three small median setæ. Ventral dististyle, *vd*, large and fleshy, the rostral prolongation with two nearly straight spines, of nearly equal length but unequal diameter, the inner slender to setiform; setæ

of apex of prolongation relatively sparse. Dorsal dististyle a chitinized sickle, sinuously to subangularly bent, the long acute tip slightly decurved. Gonapophyses, *g*, with the apex of each slightly blackened, the surface and margin before tip with erect pale points.

LUZON, Tayabas Province, Candelaria, near town, alongside a small stream, June 20 to 25, 1930 (*McGregor and Rivera*) ; holotype, male; allotype, female; paratypes, 5 of both sexes.

Limonia (*Libnotes*) *melancholica* is allied to *L.* (*L.*) *neofamiliaris* Alexander and *L.* (*L.*) *subfamiliaris* Alexander, together with the species described herewith as *L.* (*L.*) *unistriolata* sp. nov., differing in the almost uniformly black color, in addition to details of the venation and male hypopygium.

LIMONIA (LIBNOTES) PERRARA sp. nov. Plate 1, fig. 10.

General coloration of præscutum yellow in front, with four brown stripes behind; pleura yellow, with two black longitudinal stripes; halteres yellow; legs yellow, the femora with a broad dark brown subterminal ring; wings yellow, handsomely patterned with brown; Rs only slightly arcuated; m-cu just before midlength of cell 1st M_2.

Male.—Length, about 7.5 millimeters; wing, 8.5.

Female.—Length, about 7.5 millimeters; wing, 9.

Rostrum and palpi ocherous, the latter narrowly darkened at tips. Antennæ with the scape pale, the flagellum somewhat darker; flagellar segments short-oval to subcylindrical, crowded, gradually increasing in size outwardly, the terminal segment long; verticils relatively short and inconspicuous, not or scarcely exceeding the segments in either sex. Eyes of male large, contiguous; of female separated for a long distance only by a capillary strip of vertex; posterior portion of head gray.

Mesonotal præscutum in front chiefly yellow, more saturated anteriorly; four pale brown stripes on posterior half; scutal lobes brown, the median portion, with adjoining parts of præscutum and scutellum, whitish; caudal margin of scutellum narrowly blackened on either side; postnotal mediotergite gray, with a capillary pale median line. Pleura yellow, with two conspicuous blackish longitudinal areas, including a narrow dorsal stripe from the propleura to the abdomen, the second area including almost all of the sternopleurite. Halteres pale yellow. Legs with the coxæ and trochanters pale yellow; femora yellow, with a broad dark brown subterminal ring, the apical yellow

portion very narrow; tibiæ yellow; basal segments of tarsi yellow, the terminal three and distal end of the second blackened; claws with a conspicuous spine at near one-third the length, with additional smaller spines nearer the base. Wings (Plate 1, fig. 10) creamy yellow, with a handsome brown pattern, including four areas in cell Sc, the first two not encroaching on cell C, the second sending a triangular cloud along Rs; fourth area including R_2 and tip of Sc_2; cord and outer end of cell 1st M_2 seamed with brown; a broad seam on R_{2+3} for almost the entire length; a series of five oval clouds on distal portions of veins R_3 to M_4, inclusive, placed shortly before the margin; posterior margin of wing almost to tip narrowly clouded with brown; brown clouds at ends of veins Cu_1 and 2d A, the latter extended basad for about one-half the length of the vein; axilla darkened; veins yellow, brown in the clouded areas. Venation: Sc_1 ending just before the proximal end of m, Sc_2 at its tip; free tip of Sc_2 and the spur of R_{1+2} subequal, or the latter greatly reduced so that R_2 and the free tip of Sc_2 are in approximate transverse alignment; R_2 unusually long; Rs gently curved; m nearly twice as long as the basal section of M_3, gently arcuated; m-cu just before midlength of cell 1st M_2; cell 1st A at margin very much wider than cell Cu; anal veins at base almost parallel, thence divergent.

Abdomen dark brown, the caudal margins of the tergites in the male yellow; sternites paler; in female, the abdomen is more uniformly yellow, variegated laterally with blackish areas. Ovipositor dark, the cerci weakly bidentate at tips, there being a small dorsal subterminal denticle, as in the group.

LUZON, Mountain Province, Benguet Subprovince, Pauai, altitude 8,000 feet, April 21 and 22, 1930 (*F. Rivera*); holotype, male; allotype, female.

Limonia (*Libnotes*) *perrara* is a member of a group of the subgenus that includes *L.* (*L.*) *amatrix* Alexander (Japan), *L.* (*L.*) *klossi* Alexander (Federated Malay States), *L.* (*L.*) *terræ-reginæ* Alexander (Queensland), and possibly other species, in which the ovipositor has the cerci distinctly toothed on dorsal margin before apex. The nearest relative of the present species appears to be *amatrix*, which differs in venational details, as the very strongly arcuated Rs, the position of m-cu at about one-fourth the length of cell 1st M_2, and other details, and in the very distinct leg pattern.

LIMONIA (DICRANOMYIA) ORTHIA sp. nov. Plate 1, fig. 11; Plate 2, fig. 29.

General coloration dark brown; rostrum and antennæ black; halteres pale; wings milky white, with a heavy dark pattern that is chiefly marginal in distribution, there being a series of four darker costal areas, with gray clouds at wing tip and at ends of anal veins; Sc_2 far from tip of Sc_1; male hypopygium with the spines of the rostral prolongation short, placed close together on the small prolongation.

Male.—Length, about 5 millimeters; wing, 5.5.

Rostrum, palpi, and antennæ black throughout. Head brownish gray; anterior vertex narrow.

Mesonotum dark brown, the scutellum somewhat paler. Pleura blackish, pruinose. Halteres pale. Legs with the coxæ brownish testaceous, the fore coxæ darker; trochanters testaceous; remainder of legs pale brown; claws with a single long basal spine. Wings (Plate 1, fig. 11) with the ground color milky white, the prearcular and costal regions more yellowish; a heavy brown pattern that is chiefly marginal in distribution, including a series of four areas along the costal margin, the first being at arculus, the second at Sc_2, the third at end of Sc_1 and origin of Rs, the last stigmal; wing tip in outer end of cell R_3 clouded with gray; large gray clouds at ends of anal veins; cord and outer end of cell 1st M_2 seamed with gray; veins pale, darker in the clouded areas, yellow in the brightened costal portions. Venation: Sc_1 ending opposite origin of Rs, Sc_2 far from its tip, at near midlength of vein R; m-cu close to fork of M; cell 2d A moderately wide.

Abdomen dark, the incisures paler; male hypopygium with the basistyles dark, the large ventral dististyles paler. Male hypopygium (Plate 2, fig. 29) with the basistyles, *b*, small, the ventromesal lobe large. Dorsal dististyle a very strongly curved pale sickle, the extreme tip upcurved. Ventral dististyle, *vd*, a large fleshy lobe, the rostral prolongation small, the two spines straight, subequal in length and size, about as long as the prolongation itself. Gonapophyses, *g*, with the mesal-apical lobe gently curved to the acute tip.

LUZON, Mountain Province, Benguet Subprovince, Pauai, altitude 8,000 feet, April 21, 1930 (*F. Rivera*); holotype, male.

Limonia (*Dicranomyia*) *orthia* is allied to the larger Japanese species, *L.* (*D.*) *mesosternata* (Alexander) and *L.* (*D.*) *mesosternatoides* (Alexander), differing very conspicuously in the structure of the male hypopygium.

LIMONIA (DICRANOMYIA) NEOPUNCTULATA sp. nov. Plate 1, fig. 12; Plate 2, fig. 30.

Male.—Length, about 4.5 millimeters; wing, 4.8.

Generally similar and allied to *L.* (*D.*) *punctulata,* differing especially in the details of structure of the male hypopygium. The general coloration, wing pattern, and venation (Plate 1, fig. 12) are quite the same in both species.

Male hypopygium (Plate 2, fig. 30) with the dorsal dististyle, *dd,* subangularly bent beyond midlength. Ventral dististyle, *vd,* relatively small, the rostral prolongation with a single short stout spine from a raised tubercle, the spine about equal in length to the prolongation, evidently formed by the coalescence of two spines, the suture being evident. Gonapophyses, *g,* with the mesal apical lobe simply bifid.

Limonia (*D.*) *punctulata* (de Meijere) is well distinguished by the details of the hypopygium (Plate 2, fig. 31), especially the very slightly curved dorsal dististyle, the long, very slender rostral spine, *vd,* that is strongly curved at tip and without a basal tubercle, and the irregularly toothed gonapophyses, *g.*

Limonia (*D.*) *fullowayi* (Alexander) has the male hypopygium (Plate 2, fig. 32) with the dorsal dististyle, *dd,* very strongly curved to an acute point; rostral spine, *vd,* single, long, and very slender, without basal tubercle, entirely straight; gonapophyses, *g,* not evidently bifid at tips.

MINDANAO, Davao district, Calian, Lawa, May 3, 1930, at light (*C. F. Clagg*); holotype, male.

It is very evident that several species of *Limonia* center about *punctulata* in the Oriental-Eastern Palæarctic faunal regions. The three species compared above, having a single spine on the rostral prolongation of the ventral dististyle, and with the gonapophyses variously toothed at apices, seem to be well-separated by the genitalic differences as described. *Limonia* (*D.*) *subpunctulata* Alexander (Formosa) is distinct in the bispinous rostral prolongation. *Limonia* (*D.*) *fascipennis* (Brunetti), described from northern India, is possibly distinct from any of the above. It was described from a single broken female and since the name *fascipennis* has been used in *Limonia* (*Limnobia*) on two previous occasions, the name should be dropped until the species is rediscovered at or near the type locality.

HELIUS (EURHAMPHIDIA) FUSCOFEMORATUS sp. nov. Plate 1, fig. 13.

Unusually large (wing, female, over 6.5 millimeters); rostrum relatively elongate, about one-half longer than the remainder of head; mesonotum dark brown, restrictedly paler laterally; legs

black, the tips of the tibiæ narrowly snowy white, this including about the distal sixth or less of the segment.

Female.—Length, about 7 to 7.5 millimeters; wing, 6.5 to 7.

Rostrum unusually long for a member of this subgenus, about one-half longer than the remainder of head, black; palpi black. Antennæ with the basal segment obscure yellow beneath, the remainder of the organ black; flagellar segments oval, with verticils that exceed the segments. Head brownish gray.

Pronotum dark brown, restrictedly yellow behind. Mesonotum chiefly dark brown, the lateral portions of præscutum paler. Pleura brownish yellow. Halteres dusky, the base of the stem restrictedly yellow. Legs with the coxæ and trochanters yellow; femora brownish black, with no sign of brightening at genua; tibiæ black, the tips narrowly snowy white, on the posterior legs this including less than the distal sixth; tarsi white, the terminal segments blackened. Wings (Plate 1, fig. 13) with a pale brownish tinge, the oval stigma darker brown; prearcular and costal regions slightly more yellowish; a yellowish seam in cell M adjoining vein Cu; veins brown. Venation: Sc_1 ending opposite r-m, Sc_2 at its tip; basal section of M_{1+2} subequal to second section, the inner end of cell 1st M_2 being pointed; m-cu before midlength of cell 1st M_2.

Abdominal tergites dark brown, the sternites yellow, the subterminal segments more darkened. Ovipositor with the tergal valves slender, brownish black, their acutely upcurved tips pale.

LUZON, Mountain Province, Benguet Subprovince, Pauai, altitude 8,000 feet, April 26, 1930 (*F. Rivera*); holotype, female; paratype, female.

Helius (*Eurhamphidia*) *fuscofemoratus* may be confused only with *H.* (*E.*) *nigrofemoratus* (Alexander), which differs conspicuously in the small size, the short rostrum, and the increased amount of white on apices of tibiæ.

HELIUS (EURHAMPHIDIA) INDIVISUS sp. nov. Plate 1, fig. 14; Plate 2, fig. 33.

Male.—Length, about 4.6 millimeters; wing, 5.4.

Similar to *H.* (*E.*) *diacanthus* (Alexander) and *H.* (*E.*) *abnormalis* (Brunetti) in general appearance, differing especially in the structure of the male hypopygium.

Rostrum pale brown, a little longer than the remainder of head; palpi dark brown. Antennæ black. Head dark gray, the narrow anterior vertex more silvery gray.

Thoracic dorsum reddish brown, the median area of præscutum a little darker. Pleura more testaceous yellow, the dorsal re-

gion a little darker. Halteres pale, the knobs dusky. Legs with the coxæ pale; femora brown, the tips broadly and conspicuously white, tibiæ brown, the bases narrowly white, the amount about one-third that of the femoral tips; tibial tips broadly snowy white; tarsi white, the terminal segments darkened. Wings (Plate 1, fig. 14) whitish subhyaline, the stigmal region darker; veins pale brown. Venation: Sc_1 ending about opposite r-m, Sc_2 at its tip; m short to very short, cell 2d M_2 narrowed at base; cell 1st M_2 short, subquadrangular, m-cu at near midlength.

Abdominal tergites light brown, the sternites pale yellow. Male hypopygium (Plate 2, fig. 33) with the lateral spines of the tergite, *9t*, simple, not bearing basal spinules or lobes, as in *diacanthus* and *abnormalis*. Outer dististyle, *od*, with delicate but distinct erect setæ for almost the whole length; in *diacanthus* and *abnormalis* the style is glabrous. Inner dististyle, *id*, narrow, terminating in two larger setæ, the margin at base almost smooth, not expanded and provided with conspicuous tubercles, as in *diacanthus*.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,800 feet, July 3, 1930 (*C. F. Clagg*); holotype, male.

ERIOPTERINI

TRENTEPOHLIA (MONGOMA) DISTALIS sp. nov. Plate 1, fig. 15.

General coloration dark brown to brownish black; antennæ black throughout; halteres dusky; legs black, the terminal tarsal segments paling to brownish yellow; wings with a dusky tinge, the costal region more blackened; R_3 not conspicuously arcuated; cell 1st M_2 small, m-cu beyond the fork of M; abdominal tergites black.

Male.—Length, about 7 millimeters; wing, 7.2.

Female.—Length, about 7 millimeters; wing, 7.2.

Rostrum and palpi dark, the tips of the labial palpi pale yellow. Antennæ black; flagellar segments long-oval to subcylindrical, with elongated verticils. Head black, the anterior vertex reduced to a linear strip.

Mesonotum dark brown to brownish black, the median region of scutum and lateral portions of scutellum somewhat paler. Pleura dark yellowish brown, the propleura and dorsopleural membrane dark brown. Halteres dusky. Legs with the fore coxæ dark brown, the remaining coxæ and all trochanters more testaceous brown; remainder of legs black, the terminal tarsal segments paling to brownish yellow; legs without specially devel-

oped armature of any kind. Wings (Plate 1, fig. 15) with a dusky tinge, cells C and Sc more blackish; the small ill-delimited stigma and an apical suffusion paler brown; veins brownish black. Venation: Sc_1 ending just beyond proximal end of R_2; Rs shorter than R_{2+3+4}; R_2 at or close to the fork of R_{3+4}; R_3 gently sinuous but not conspicuously arcuated at origin; cell 1st M_2 small, the fusion of R_{4+5} and M_{1+2} subequal to or one-half longer than the second section of M_{1+2}, the proximal end of cell R_5 lying proximad of any other beyond the cell; m-cu from two-thirds to nearly its own length beyond the fork of M, at beyond one-third the length of cell 1st M_2; apical fusion of Cu_1 and 1st A slight.

Abdominal tergites and hypopygium black; basal sternites yellow, blackened laterally, beyond the second segment passing into black. In the female, the sternites more uniformly brown, with narrow glabrous apical margins. Ovipositor with the cerci relatively long and slender.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, July 2 and 3, 1930 (*C. F. Clagg*); holotype, male; allotype, female. "Among ferns and on mossy trees."—Clagg.

By my most recent key to the Philippine species of *Trentepohlia* [2] the present species runs to couplet 8, disagreeing with both included species in the position of m-cu, and in other characters. It may be noted that there is a slight typographical error in this couplet, the last symbol, M_3, of the second alternative (*riverai*) correctly being M_{1+2} to agree with the first alternative (*brevifusa*).

GONOMYIA (PROGONOMYIA) TEREBRELLA sp. nov. Plate 1, fig. 16.

General coloration of mesonotum reddish brown; antennæ black throughout; halteres dusky; wings with a strong brown suffusion; Sc long, Sc_1 ending opposite the fork of Rs; vein R_3 at margin close to R_{1+2}, cell R_2 being very narrow; ovipositor with the tergal valves long and chitinized, the sternal valves reduced to tiny blackened hairy lobes.

Female.—Length, about 5 millimeters; wing, 4.8.

Rostrum and palpi black. Antennæ black throughout, relatively elongate for this sex; flagellar segments oval, the verticils exceeding the segments. Head brown, sparsely pruinose.

Pronotum whitish. Mesonotal præscutum reddish brown, the median area blackened; scutum reddish brown, the centers of the

[2] Philip. Journ. Sci. 43 (1930) 297–298.

lobes conspicuously blackened; scutellum dark medially at base, the apex broadly testaceous; postnotal mediotergite black, sparsely pruinose. Pleura dark brown, variegated with light and dark areas, the obscure yellow including the dorsopleural membrane and areas dorsad of the mid- and hind-coxæ; the blackened areas occur as spots on the dorsal anepisternum and dorsal pteropleurite. Halteres dusky. Legs with the coxæ infuscated; trochanters obscure yellow; remainder of legs black, the femoral bases broadly obscure yellow. Wings (Plate 1, fig. 16) with a strong brown tinge, the stigmal region vaguely and diffusely darker; veins brownish black. Macrotrichia of costa and veins relatively long and conspicuous. Venation: Sc long, Sc_1 ending opposite the fork of Rs, Sc_2 some distance from its tip, Sc_1 being equal to R_{2+3+4}; R_3 and R_4 strongly divergent, R_3 at margin closely approaching R_{1+2}, cell R_3 being very narrow at margin; cell 2d M_2 deep; m-cu a short distance beyond the fork of M, in alignment with the other elements of the cord.

Abdomen black, the subterminal sternites paler; genital sheaths blackened. Tergal valves of ovipositor elongate, straight, reddish horn color; sternal valves reduced to tiny blackened hairy lobes, directed ventrad.

MINDANAO, Davao district, Calian, June 13, 1930, trap lantern set at edge of forest (*C. F. Clagg*); holotype, female.

Gonomyia (*Progonomyia*) *terebrella* is closest to *G.* (*P.*) *tenebrosa* Edwards (Siam) in the general coloration and structure of the ovipositor, differing in the details of venation, especially the unusually long Sc, which ends opposite the fork of Rs. The fly differs more widely from *G.* (*P.*) *brunnescens* Edwards (Borneo) in coloration and venation.

Genus ERIOPTERA Meigen

Subgenus TELENEURA subgen. nov.

Characters as in the typical subgenus, differing especially in the wing venation. Mesonotal præscutum with longitudinal rows of long erect setæ on interspaces. Veins and cells beyond the cord very elongate, the cord lying at or before midlength of the wing (Plate 1, fig. 17). Rs very short, subequal to or only a little longer than R_{2+3+4}; cell 1st M_2 open by atrophy of m; m-cu at fork of M; veins M_4 and Cu_1 deflected only slightly, cephalad at their tips; vein 2d A only gently sinuous.

In typical *Erioptera,* Rs is three or more times as long as R_{2+3+4}, the slightly oblique cord lying at or beyond three-fifths the length of the wing; vein 2d A very strongly sinuous, the distal third or fourth paralleling the anal margin of wing.

Type of subgenus, *Erioptera fusca* de Meijere (Oriental Region).

Other species pertaining to *Teleneura* are *Erioptera argentifrons* Edwards, *E. melanotænia* sp. nov., *E. nigribasis* Edwards, *E. parallela* Brunetti, *E. punctipennis* Brunetti, and *E. subfusca* Edwards, all Oriental. These species may be separated by means of the following key:

1. Wings variegated with dark areas, either on the membrane itself or as conspicuous darkened hair patches on the veins .... 2.
   Wings uniform in color .... 3.
2. Femora yellow, the tips imperceptibly darkened (British India: Himalayas) .... *punctipennis* Brunetti.
   Femora yellow, with about the basal half blackened (Malay Peninsula and Borneo) .... *nigribasis* Edwards.
3. General coloration brownish ocherous, without conspicuous markings (British India: Himalayas; Malay Peninsula) .... *parallela* Brunetti.
   General coloration dark brown to black; if pale, variegated with black longitudinal markings .... 4.
4. Halteres with at least the knobs yellow .... 5.
   Halteres with the knobs blackened .... 6.
5. Halteres yellow; general coloration of thorax dark brown; male hypopygium without conspicuous modified setæ at apex of basistyle; gonapophyses simple, crook-shaped (Sumatra and Borneo). *subfusca* Edwards.
   Halteres with the stem black, the knobs yellow; general coloration of thorax black; male hypopygium with a group of about five powerful setæ at apex of basistyle; gonapophyses bispinous, tonglike (Federated Malay States) .... *argentifrons* Edwards.
6. Thorax brown, the lateral margins of præscutum pale; dorsal thoracic pleura with a narrow blackened longitudinal stripe (Luzon and Mindanao) .... *melanotænia* sp. nov.
   General coloration of thorax uniform dark brown or black (Federated Malay States and Mindanao) .... *fusca* de Meijere.

ERIOPTERA (TELENEURA) FUSCA de Meijere.

Erioptera fusca DE MEIJERE, Tijdsch. v. Entom. 56 (1913) 351.

La Lun Mountains, Calian, Davao district, Mindanao, altitude 5,800 feet, July 3, 1930 (*C. F. Clagg*). The specimens are almost black, instead of dark brown, but there seems to be no doubt as to the identity.

ERIOPTERA (TELENEURA) MELANOTÆNIA sp. nov. Plate 1, fig. 17; Plate 2, fig. 34.

Mesonotal præscutum light brown, margined with obscure yellow; pleura pale, with a black dorsolongitudinal stripe; knobs of halteres brownish black; wings with a brown tinge.

Male.—Length, about 2.5 millimeters; wing, 3.

Female.—Length, about 3 millimeters; wing, 3 to 3.2.

Rostrum and palpi black. Antennæ black. Head light ocherous, dark brown in center of vertex and on occiput.

Mesonotal præscutum and scutum brown to dark brown, the lateral margins paling to obscure yellow. Pleura obscure yellow, including the dorsopleural region and dorsal pleurotergite lying above, and the dorsal meron and sternopleurite lying below, a broad black dorsal stripe that extends from the propleura to the abdomen; ventral sternopleurite and meron again darkened. Halteres obscure yellow, the knobs brownish black. Legs with the fore coxæ dark, the remaining coxæ and trochanters obscure yellow; femora obscure yellow, this coloration obscured by dark setæ. Wings (Plate 1, fig. 17) with a brownish tinge, the base and costal region somewhat more yellowish brown; veins pale brown, the macrotrichia dark. Venation: As in the subgenus; vein 2d A ending opposite m-cu.

Abdomen brownish black, the hypopygium paler. Male hypopygium (Plate 2, fig. 34) with the tergal plate (*9t*, one-half figured) margined with conspicuous spines. Apex of basistyle, *b*, without specially modified setæ. Outer dististyle, *od*, pale, at apex expanded into a blackened setiferous head; inner dististyle, *id*, a pale flattened blade, the distal third more narrowed. Longest gonapophysis, *g*, more or less crook-shaped, its apex cultriform, the two together appearing somewhat lyriform; shorter gonapophysis, *g*, more foot-shaped, the surface with abundant delicate setæ, including a tuft of longer setæ at the region of the "heel."

LUZON, Laguna Province, Ube, February, 1930 (*F. Rivera*); holotype, male; allotype, female; numerous paratypes of both sexes. MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 feet, July 2 to 5, 1930 (*C. F. Clagg*); paratypes, 5 males and females.

ERIOPTERA (EMPEDA) LUNENSIS sp. nov. Plate 1, fig. 18; Plate 3, fig. 35.

General coloration of præscutum brown medially, the lateral portions gray; antennæ black, the first flagellar segment pale yellow; head blue-gray; halteres pale yellow; legs light brown, appearing darker by a covering of scales and setæ; Sc_1 ending opposite origin of Rs; cell R_3 very deep.

Male.—Length, about 2.5 millimeters; wing, 2.8 to 3.

Female.—Length, about 3.5 millimeters; wing, 3.3.

Rostrum and palpi black. Antennæ with the scape and flagellum black, the first flagellar segment abruptly pale yellow. Head light blue-gray.

Pronotum and anterior lateral pretergites whitish. Mesonotal præscutum dark brown medially, the sides light gray to blue-gray; posterior sclerites of mesonotum chiefly darkened, the posterior margin of scutellum more brightened, the postnotal mediotergite light gray pruinose. Pleura dark, sparsely pruinose, the dorsopleural membrane restrictedly pale. Halteres pale yellow. Legs with the coxæ reddish brown, the fore coxæ darker; trochanters reddish brown; remainder of legs light brown, the terminal tarsal segments passing into black; legs with flattened scales, in addition to the usual setæ. Wings (Plate 1, fig. 18) grayish, the base and costal region more yellowish; veins brown. Costal fringe relatively long and conspicuous. Venation: Sc_1 ending opposite origin of Rs, Sc_2 faint, at tip of Sc_1; R_2 slightly oblique in position, shorter than R_{2+3+4} and about one-third R ; cell R_3 unusually deep, approaching the condition in typical *Erioptera*, vein R_3 subequal to or only a little shorter than Rs; cell M_2 open; m-cu at or just before the fork of M.

Abdominal tergites brown, the sternites paler; hypopygium obscure yellow. Male hypopygium (Plate 3, fig. 36) with the outer dististyle, *od*, profoundly bifid, entirely glabrous, both arms flattened and obtuse at tips. Inner dististyle, *id*, a pale flattened blade, the distal half with microscopic sensory setæ.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 to 5,800 feet, July 3 and 4, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 12 of both sexes. "Swept from among ferns and undergrowth on margins of small brook; others at trap lantern hung among ferns in dense mossy forest."—Clagg.

Erioptera (*Empeda*) *lunensis* is most closely allied to *E.* (*E.*) *gracilis* (de Meijere), differing in the coloration and in details of venation, as the shorter Sc and deeper fork of cell R_3. Both species have conspicuous flattened and striated scales on the legs, interspersed with the usual setæ.

MOLOPHILUS BANAHAOENSIS sp. nov. Plate 1, fig. 19; Plate 3, fig. 36.

Belongs to the *gracilis* group; allied to *M. kempi;* antennæ (male) elongate; general coloration of body, antennæ, halteres, and legs blackish; wings tinged with blackish; vein 2d A relatively short; male hypopygium with the dorsal lobe of basistyle expanded at apex into a glabrous spatulate head; ventral lobe of basistyle with long coarse retrorse setæ.

Male.—Length, about 2.8 millimeters; wing, 3.5; antenna, about 2.5.

Female.—Length, about 3 millimeters; wing, 3.2.

Rostrum and palpi black. Antennæ with the scapal segments obscure yellow; flagellum black; antennæ (male) nearly as long as entire body; flagellar segments fusiform, the apical necks longer and slenderer than the narrow basal portion. Head black, sparsely pruinose.

Mesonotum black, the humeral region restrictedly paler; pseudosutural foveæ black; anterior lateral pretergites restrictedly obscure yellow. Pleura black, the ventral sternopleurite and meron a little paler. Halteres blackened, the base of the stem obscure yellow. Legs with the coxæ and trochanters obscure yellow; remainder of legs blackened. Wings (Plate 1, fig. 19) with a strong blackish tinge, the veins more seamed with darker, the extreme wing tip pale; veins and macrotrichia dark brown to black. Venation: R_2 and r-m in transverse alignment; vein 2d A relatively short, ending some distance before the proximal end of m-cu.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 36) with the basistyle, *b*, produced at apex into four distinct lobes, the outermost a small glabrous spine on outer dorsal margin; immediately laterad of this, on dorsal margin a long hairy fingerlike lobe, the apex, *db*, expanded into an obtuse glabrous spatula; mesal lobe flattened, narrowed outwardly and here provided with several long coarse setæ; ventral lobe, *vb*, longer than the mesal, more or less clavate, at apex with a group of very long, coarse, retrorse setæ (only the bases of which are shown in the figure), the longest about two-fifths the entire lobe. Outer dististyle, *od*, a glabrous blackened spine, the tip acute. Inner dististyle, *id*, subequal in length, yellow, dilated on basal half, the inner margin on basal fifth with a few setæ; apex narrowed into a spine, with a few microscopic spinulæ on outer margin before apex.

LUZON, Laguna Province, Ube (*R. C. McGregor*); holotype, male, February 12, 1930; allotype, female, April 14, 1930.

Molophilus banahaoensis is closely allied to *M. kempi* Alexander (British India: Eastern Himalayas), differing especially in the structure of the male hypopygium.

MOLOPHILUS PROCERICORNIS sp. nov. Plate 1, fig. 20; Plate 3, fig. 37.

Belongs to the *gracilis* group; general coloration of mesonotum dark brown; antennæ (male) elongate; pleura reddish yellow, variegated with brown; knobs of halteres weakly infus-

cated; male hypopygium large and conspicuous, the dorsal lobe of the basistyle terminating in a flattened glabrous blade; two dististyles, one an acutely pointed black spine.

Male.—Length, about 3.5 millimeters; wing, 4; antenna, about 2.8.

Rostrum reddish brown; palpi black. Antennæ (male) elongate, if bent backward extending to beyond midlength of the body; scapal segments obscure yellow; flagellum black; flagellar segments elongate-fusiform, with long outspreading black verticils at thickest part. Head light gray, the anterior vertex paler.

Anterior lateral pretergites pale yellow. Mesonotal præscutum with the humeral and lateral portions pale yellow, the remainder of disk chiefly covered by three dark brown stripes that are confluent or nearly so; median vitta slightly divided behind; scutal lobes dark brown; scutellum pale; postnotal mediotergite reddish brown. Pleura reddish yellow, variegated with dark brown or dorsopleural membrane and anepisternum; ventral sternopleurite and meron darkened. Halteres pale, the knobs weakly infuscated. Legs with the coxæ and trochanters yellow; remainder of legs obscure yellow, the vestiture chiefly dark; tarsal segments passing into brown. Wings (Plate 1, fig. 20) grayish yellow, the prearcular and costal regions brighter yellow; veins brownish yellow, the macrotrichia a little darker. Venation: R_2 lying distad of the level of r-m; vein 2d A relatively short, ending before the caudal end of m-cu.

Abdominal tergites brownish black, the sternites paler, the large hypopygium obscure yellow, with blackened dististyles. Male hypopygium (Plate 3, fig. 37) with the basistyles, *b*, relatively short and stout; dorsal lobe, *db*, long and relatively slender, setiferous for almost the entire length, the apex a short, sinuous, glabrous blade; ventral lobe, *vb*, short and broad, with abundant long retrorse setæ; an additional ventral lobe (not figured), small and very slender, pale, fleshy, with from six to eight setæ at and near apex, the total length being somewhat less than the main ventral lobe. Two dististyles, the outer, *od*, blackened, from a dilated flask-shaped base, the remainder a sinuous black spine. Inner dististyle, *id*, a little longer, the basal two-thirds or slightly more pale yellow, the gently curved apex blackened. Ædeagus elongate, with a conspicuous lateral flange.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 to 5,800 feet, July 2 to 4, 1930 (*C. F. Clagg*); holotype, male; paratypes, 5 males.

Molophilus procericornis is quite distinct from other members of the *gracilis* group, the chief characters being antennal and hypopygial. Females in the same collection do not seem to be conspecific and are not further discussed.

MOLOPHILUS MENDICUS sp. nov. Plate 3, fig. 38.

Belongs to the *gracilis* group; general coloration of mesonotum brownish gray; antennæ short in both sexes; halteres dusky; wings pale grayish, the veins pale; vein 2d A relatively short; male hypopygium with all lobes of basistyle fleshy and setiferous to their obtuse tips, the outer lobe bearing a blackened spinous point.

Male.—Length, about 2.8 millimeters; wing, 3.4.

Female.—Length, about 3.5 millimeters; wing, 3.5.

Rostrum and palpi dark brown. Antennæ short in both sexes, brown throughout, in the female somewhat paler. Head grayish brown.

Mesonotum brownish gray, the lateral margin and humeral region somewhat brighter, inclosing the relatively small reddish brown pseudosutural foveæ; scutellum obscure yellow, darkened medially; postnotal mediotergite plumbeous brown. Pleura plumbeous. Halteres dusky. Legs pale brown, the color chiefly produced by the vestiture; tips of tibiæ and outer tarsal segments darker. Wings with a pale grayish tinge, the veins very pale; macrotrichia dark brown. Venation: R_2 lying some distance before the level of r-m, R_{2+3+4} thus shortened, about two-thirds the basal section of R_5; vein 2d A short, ending before the level of the caudal end of m-cu.

Abdomen dark brown, the genitalia in both sexes more yellowish. Male hypopygium (Plate 3, fig. 38) with the three lobes of the basistyle, *b*, all fleshy, obtuse, provided with setæ to their tips; on margin of outer lobe, on inner face, a curved blackened hook; mesal lobe small and slenderer. Two dististyles, *d;* these entirely pale and generally similar in outline, one a little more expanded on basal half, the distal half slender, with small subappressed spines before apex, at tip with two or three setiferous punctures; second style a straight flattened blade, slightly constricted at near midlength, at apex with a very few weak spinous points. Phallosomic structure a pale cushion that is densely set with microscopic setulæ. Ædeagus very long and slender, the base more dilated.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,800 feet, July 3, 1930 (*C. F. Clagg*); holotype, male; allo-

type, female. "Among ferns and undergrowth along margins of small brook."—Clagg.

Molophilus mendicus is a small, insignificant species that is best characterized by the details of structure of the male hypopygium.

MOLOPHILUS TAWAGENSIS sp. nov. Plate 3, fig. 39.

Belongs to the *gracilis* group; general coloration of mesonotum light grayish brown; antennæ (male) short; pronotum and anterior lateral pretergites white; pleura liver brown; halteres with infuscated knobs; wings pale grayish, the costal region clear light yellow, the posterior prearcular region infumed; male hypopygium with only two lobes on the elongate basistyle, both obtuse and with setæ to their tips; a blunt setiferous lobe on mesal face of basistyle near origin; two dististyles.

Male.—Length, about 3.5 millimeters; wing, 4.5.

Rostrum and palpi black. Antennæ (male) short, the basal segments pale, the outer segments darkening to brown. Head pale gray.

Pronotum and anterior lateral pretergites white. Mesonotal præscutum light grayish brown, paling to clearer gray on sides; humeral and lateral portions pale yellow; pseudosutural foveæ relatively large, reddish brown; median region of scutum grayish; scutellum pale testaceous brown; postnotal mediotergite gray. Pleura relatively dark liver brown. Halteres obscure golden yellow, the knobs infuscated. Legs with the coxæ brownish yellow; trochanters obscure yellow; remainder of legs chiefly brown, the terminal tarsal segments more blackened. Wings pale grayish, the costal region clear light yellow; posterior prearcular region darkened; veins pale, the macrotrichia darker. Venation: R_2 faint, lying opposite the basal section of R_5; vein 2d A ending just before the caudal end of m-cu.

Abdomen brown, the hypopygium yellow. Male hypopygium (Plate 3, fig. 39) with the basistyles, *b*, relatively elongate, with a very deep incision down the face, separating the lateral and mesal lobes. Lateral lobes slender, much shorter than either dististyle, with setæ to the obtuse tip; mesal lobe flattened; on mesal face of basistyle, closer to base, a broad lobe set with coarse setæ. Outer dististyle, *vd*, more slender, terminating in a long acute spinous point, the surface at near midlength a trifle roughened. Inner dististyle, *id*, broader, with a conspicuous flange on basal half, the terminal bladelike portion with microscopic scattered setæ. Surface of phallosomic structure with delicate microscopic setulæ.

LUZON, Mountain Province, Ifugao Subprovince, Tawag, April 6, 1930 (*F. Rivera*) ; holotype, male.

Molophilus tawagensis belongs to the *costalis* subgroup, including many species in the fauna of eastern Asia. The details of the male hypopygium furnish the best characters for the separation of the various forms.

Genus STYRINGOMYIA Loew

Styringomyia LOEW, Dipt. Beitr. 1 (1845) 6.
Idiophlebia GRUNBERG, Zoöl. Anzeiger 26 (1903) 524–528.
Pycnocrepis ENDERLEIN, Zoöl. Jahrbucher 32 (1912) 65.
Mesomyites COCKERELL, Proc. U. S. Nat. Mus. 52 (1917) 377.

The now rather numerous Philippine species of *Styringomyia* may be separated in the male sex by means of the following key:

1. Wings with a strong blackish tinge, the basal fourth more yellowish; legs black, the femora with a narrow yellow subterminal ring. *fumipennis* Edwards.
   Wings yellow or yellowish, immaculate, or spotted and washed with darker .... 2.
2. General coloration of mesonotum gray; legs uniformly brown; wings unmarked with darker; male hypopygium without specially enlarged setæ on apical lobe of basistyle........ *mcgregori* Alexander.
   General coloration of mesonotum yellow, variegated with black; legs yellow, the femora and tibiæ ringed or spotted with brown; wings yellow, patterned with brown, at least with a small darkened spot at arculus; male hypopygium with the basistyle terminating in one or two enlarged spinous setæ........ 3.
3. Wings unmarked, except for a tiny darkened spot at arculus........ 4.
   Wings spotted or washed on disk with darker........ 5.
4. Mesonotum pale yellow, the præscutum without distinct markings; halteres pale yellow; abdominal tergites with two small brown spots on caudal margin; male hypopygium with the phallosome including a flattened plate, its margin microscopically serrulate. *luteipennis* sp. nov.
   Mesonotum with the præscutum yellow, with two black lines before the suture; halteres dusky; abdominal tergites with the marginal spots confluent to form bands; male hypopygium not as above, the phallosome an elongate hook........ *montina* sp. nov.
5. Male hypopygium with basistyle at apex terminating in two spinous setæ .... 6.
   Male hypopygium with basistyle at apex terminating in a single setæ .... 7.
6. Wings relatively long and narrow, the anterior branch of Rs subtransverse; male hypopygium with the intermediate and inner arms of dististyle small and inconspicuous........ *armata* Edwards.
   Wings of normal shape, the anterior branch of Rs oblique, as usual in the genus; male hypopygium with the inner arm of dististyle expanded into an oval blade........ *claggi* sp. nov.

7. Male hypopygium with the outer arm of the dististyle a long slender rod that terminates in a very long seta .... 8.
   Male hypopygium with outer arm of the dististyle variously formed, not bearing an apical seta .... 10.
8. Wings with the veins and cells behind the anterior margin strongly washed with brown, the broad costal border yellow.
   flavocostalis Alexander.
   Wings yellow, with the usual four restricted dark clouds, located on the anterior cord, outer end of cell 1st M_2, m-cu, and distal end of vein 2d A .... 9.
9. Wings with vein 2d A curved at end; male hypopygium with the ninth sternite at apex very broad, heavily blackened, clothed with delicate erect setæ, the two enlarged apical bristles widely separated.
   nigrosternata sp. nov.
   Wings with vein 2d A short-spurred at end; male hypopygium with the ninth sternite entirely pale, narrowed to a point outwardly, the two apical bristles thus appearing approximated to actually contiguous .... *ceylonica* Edwards.
10. Male hypopygium with the outer arm of the dististyle a simple blackened spine, the tip acute .... *tablasensis* Alexander.
    Male hypopygium with the outer arm of the dististyle a powerful structure, at apex produced mesad at a right angle into a spikelike point.
    neocolona sp. nov.

STYRINGOMYIA FUMIPENNIS Edwards.

Styringomyia fumipennis EDWARDS, Notulæ Entomologicæ 6 (1926) 37.

Type locality: Mount Banahao, Luzon. One male, Mount Tabuan, Cagayan, Luzon, May, 1929 (*F. Rivera*).

STYRINGOMYIA MCGREGORI Alexander.

Styringomyia mcgregori ALEXANDER, Philip. Journ. Sci. 28 (1925) 373–374.

Type locality: Manila, October, 1924 (*R. C. McGregor*). Several additional specimens, Manila, October, 1929 and 1930, at light (*McGregor*). Mr. Edwards informs me that he has seen it from Borneo and the Andaman Islands.

STYRINGOMYIA LUTEIPENNIS sp. nov. Plate 3, fig. 40.

General coloration pale yellow, the mesonotal præscutum without distinct markings; wings pale yellow, unmarked except for a dusky spot at arculus; halteres yellow; abdominal tergites with two separate brown spots on caudal margin of each; male hypopygium with a single lateral enlarged seta on basistyle; dististyle expanded into a broadly flattened blade.

Male.—Length, about 5.5 millimeters; wing, 3.5 to 3.7.

Rostrum and palpi yellow. Antennal scape brownish yellow, especially on lower face; flagellum entirely pale yellow. Head pale yellow.

Mesonotum pale yellow, the præscutum without distinct markings; postnotal mediotergite with narrow brown lateral lines. Pleura yellow. Halteres pale yellow. Legs yellow, the femora with two restricted brown areas on outer face only; tibiæ with an incomplete brown ring before midlength, the tips infuscated; tarsi yellow, the last segment dark brown. Wings pale yellow, unmarked except for a small dusky area at arculus; veins deeper yellow but still very indistinct. Venation: Anterior branch of Rs oblique; cell 2d M_2 short-sessile to more broadly sessile, in rare cases with a very short petiole; m-cu about its own length beyond the fork of M; vein 2d A curved gently to margin.

Abdomen yellow, each tergite with two brown spots on caudal margin; hypopygium yellow. Male hypopygium (Plate 3, fig. 40) small, the ninth tergite, *9t*, terminating in a cordate setiferous lobe, the apex narrowed but obtuse. Ninth sternite, *9s*, broad, pale, with two widely separated spinous setæ, the intervening space very gently concave. Basistyle, *b*, with a single developed apical spinous seta, its basal lobe small; a reduced set beside the major spine. Dististyle, *d*, with the outer arm pale, terminating in the usual very long seta, at base with a group of about fifteen spines and a marginal comb of ten to twelve close-set spines; main blade of dististyle broadly flattened, with abundant long black spinous setæ; two pale arms at base of dististyle, the shorter with marginal setæ, the outermost a stout black spine; longer cephalic arm slenderer, terminating in a group of six or seven stout spines. Phallosome, *p*, with a group of spinous setæ on either side; a flattened dark plate, its apex truncate, the margins microscopically serrulate.

LUZON, Laguna Province, Mount Maquiling, January 29, 1930 (*A. C. Duyag*); holotype, male; paratypes, 8 males; above Ube, foot of Mount Banahao, February 3 to 6, 1930 (*F. Rivera*); paratypes, 2 males.

Styringomyia luteipennis much resembles *S. flava* Brunetti and *S. taiwanensis* Alexander in the yellow wings, but belongs to a different section of the genus, having but a single spinous seta at apex of basistyle of male hypopygium. The small brown spot at arculus and the structure of the male hypopygium furnish distinctive features.

STYRINGOMYIA MONTINA sp. nov. Plate 3, fig. 41.

Generally similar and closely related to *S. luteipennis* sp. nov., differing in slight details of coloration and structure of the male hypopygium. Size larger and form stouter. First scapal

segment beneath and entire second segment blackened. Mesonotal præscutum with two blackish lines before the suture. Halteres dusky. Wings somewhat deeper yellow, especially in the radial field, the veins correspondingly more distinct. Abdominal tergites with the margins on caudal margin large, confluent, to form apical bands. Male hypopygium (Plate 3, fig. 41) generally as in *luteipennis*, but the phallosome, *p*, entirely different, terminating in an elongate hook, on outer margin with numerous erect spinous setæ and true spines.

LUZON, Mountain Province, Ifugao Subprovince, Pakawan, April 7, 1930 (*F. Rivera*); holotype, male; paratypes, 2 males; Banaue, April 4, 1930 (*F. Rivera*); allotype, female.

STYRINGOMYIA ARMATA Edwards. Plate 3, fig. 42.

Styringomyia armata EDWARDS, Ann. & Mag. Nat. Hist. IX 13 (1924) 274; Treubia 9 (1927) 355, fig. *b*.

Type locality: Mindanao. Lawa, Calian, Davao district, Mindanao, April 28, 1930 (*C. F. Clagg*); Calian, July 14, 1930 (*C. F. Clagg*), at light of house. The latter specimen is accompanied by the following note: "This walked across table with a sort of dancing motion, raising its body up and down, at regular intervals of about one-half second."

I believe the identification to be correct, despite certain details lacking in the original description. The present fly has the wing unusually long and narrow for a member of the genus, with the anterior branch of Rs subtransverse, as shown (Plate 1, fig. 21). The male hypopygium (Plate 3, fig. 42) is again illustrated, the chief characters being the bispinous basistyle, *b*, and the great reduction in size of the intermediate and posterior branches of the dististyle, *d*.

STYRINGOMYIA CLAGGI sp. nov. Plate 1, fig. 22; Plate 3, fig. 43.

General coloration yellow, heavily variegated with black; palpi and antennal scape black, the flagellum yellow; head and thorax without flattened setæ; legs with complete rings on femora and tibiæ; male hypopygium with two apical spinous setæ on basistyle, these arising from elongate tubercles; main arm of dististyle a broadly flattened blade.

Male.—Length, about 6 to 6.3 millimeters; wing, 4.5 to 5.

Female.—Length, about 5 to 5.5 millimeters; wing, 4 to 4.5.

Rostrum and palpi brownish black. Antennæ with the scape black, the flagellum abruptly pale yellow, the outer segments a trifle more darkened. Head blackish, without flattened setæ.

Pronotum obscure yellow medially, more blackened laterally. Mesonotal præscutum with the disk obscure yellow, the margin and two intermediate vittæ before the suture more blackened; scutum with the median area and centers of the lobes obscure yellow, the latter margined with blackish; scutellum blackened, the median region restrictedly obscure yellow; postnotal mediotergite black, with a capillary yellow median vitta. Pleura obscure yellow, the dorsal sclerites darker. Halteres obscure yellow; knobs dark brown. Legs with the coxæ and trochanters pale yellow; femora yellow, with two broad complete brownish black rings, in addition to the narrowly darkened tips; the more basal yellow annulus a little wider than the inclosing dark rings; outer yellow annulus narrow; tibiæ yellow, the tips and a subequal ring on basal half black; tarsi yellow, the outer segment blackened, the narrow tips of the other segments infuscated. Wings (Plate 1, fig. 22) yellow, with ill-delimited brown washes, including the anterior cord, vein Cu and vein 2d A; veins pale brown, C, Sc, and R more yellowish. Venation: Anterior branch of Rs normally oblique; cell 2d M_2 sessile; vein 2d A curved gently to the margin.

Abdominal tergites light brown, the caudal margins darker brown, the sternites and hypopygium yellow. Male hypopygium (Plate 3, fig. 43) with the apical lobe of the ninth tergite, 9*t*, low and obtuse, densely hairy. Ninth sternite 9*s*, narrowed apically, the terminal setæ not widely separated. Basistyle, *b*, with two relatively short apical spinous setæ from long basal tubercles. Outer arm of dististyle, *d*, a long pale structure with the usual very elongate terminal seta; main arm of dististyle a broadly flattened blade, with long setoid spines that are chiefly marginal in distribution, there being a row along outer edge and a dense patch on mesal margin at near midlength.

MINDANAO, Davao district, Calian, La Lun Mountains, altitude 5,500 to 5,800 feet, July 3 and 4, 1930, by sweeping vegetation (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 1 male, 1 female; Mount Apo, 7,000 to 8,000 feet, September 21, 1930 (*Clagg*); paratypes, 1 male and 1 female.

This interesting *Styringomyia* is dedicated to my friend Mr. Charles F. Clagg, who has collected very numerous new and rare Tipulidæ in the highest mountains of Colorado and Mindanao. The species is allied to *S. ensifera* Edwards, *S. armata* Edwards, and *S. acuta* Edwards, in the bispinous basistyle of the male hypopygium, differing in the unmodified setæ of the

head and thorax, and the details of the hypopygium, notably the greatly expanded inner arm of the dististyle.

STYRINGOMYIA FLAVOCOSTALIS Alexander.

Styringomyia flavocostalis ALEXANDER, Philip. Journ. Sci. 27 (1925) 76–77.

Type locality: Mount Maquiling, Luzon. Additional specimens, Ube, Laguna Province, Luzon, altitude 300 to 400 meters, January 26, 1930 (*R. C. McGregor*).

STYRINGOMYIA NIGROSTERNATA sp. nov. Plate 3, fig. 44.

General coloration chiefly pale; rostrum, palpi, and antennal scape blackened; mesonotal præscutum with a broad medial darkening; pleura yellow; wings pale yellow, with the usual dark spots; male hypopygium with the basistyle unispinous, this spinous seta arising from a very long basal tubercle; ninth sternite heavily blackened at apex, clothed with delicate erect black setæ.

Male.—Length, about 6 millimeters; wing, 4.6.

Rostrum and palpi brownish black. Antennæ with the scapal segments black, the flagellar segments brownish yellow. Head brownish gray, the usual setæ stout but not flattened.

Pronotum gray medially, brownish black laterally. Mesonotal præscutum chiefly ocherous, with a sparse gray bloom, the median region on anterior half with a broad brownish black stripe; a small blackish spot on either side at the suture, this area extended across the suture and partially encircling the scutal lobes on outer side; scutellum pale, with a dark spot on either side; postnotal mediotergite chiefly dark brown. Pleura light yellow. Halteres yellow, the knobs slightly more orange. Legs with the coxæ and trochanters pale yellow; femora yellow, with two narrow, incomplete brown rings; tibiæ yellow, the tips and an incomplete ring before midlength brown; tarsi yellow, the tips of the individual segments weakly darkened. Wings pale yellow, with the usual four or five brown clouds, these being on anterior cord, union of M_2 and M_3, fork of M_{3+4}, m-cu, and the distal third of vein 2d A; veins yellow, dark brown in the infuscated areas. Venation: Anterior branch of Rs normally oblique; cell 2d M_2 short-petiolate; vein 2d A curved strongly into the margin, not angulated.

Abdominal tergites yellow, the caudal margins of the segments with two small brown triangles, these becoming larger and confluent on the outer segments; in addition to the above, a median

brown clouding on basal half of tergites, on outer segments heavier and more clearly delimited; sternites and hypopygium yellow. Male hypopygium (Plate 3, fig. 44) with the apical lobe of the tergite, *9t*, long-triangular, the tip obtuse. Ninth sternite, *9s*, broad, the apex extensively and conspicuously blackened, the two apical spines unusually short, arising from small elevated tubercles, the surface of the lobe with short erect black setæ. Basistyle, *b*, with a single terminal spinous seta, this unusually short, less than one-half the long basal tubercle. Dististyle, *d*, with the outer arm terminating in a long seta, without spines at base; intermediate arm produced laterad into a long acute spine at near midlength, the base of this spine and the arm beyond with a row of black spines; inner arm a curved chitinized rod, the tip obliquely acute and slightly blackened; outer margin of arm at midlength with a linear group or crest of about ten to twelve spines; mesal face of arm at base with a group of long spinous setæ.

MINDANAO, Davao district, Lawa, at trap lantern, April 24, 1930 (*C. F. Clagg*); holotype, male.

Styringomyia nigrosternata is very different from other regional species in the structure of the male hypopygium, especially the dististyle and ninth sternite.

STYRINGOMYIA CEYLONICA Edwards.

Styringomyia ceylonica EDWARDS, Ann. & Mag. Nat. Hist. VIII 8 (1911) 62–63.

Type locality: Weligama, Ceylon. The following authentic Philippine records are available: Badajoz, Tablas, August 28, 1928 (*F. Rivera and A. C. Duyag*); Lawa, Davao district, Mindanao, at light, April 24, 1930 (*C. F. Clagg*).

Bezzi [3] recorded this species from Los Baños and Mount Maquiling, but this record is almost certainly erroneous, as previously indicated by Edwards.[4]

STYRINGOMYIA TABLASENSIS Alexander.

Styringomyia tablasensis ALEXANDER, Philip. Journ. Sci. 40 (1929) 344–345.

Type locality: Badajoz, Tablas, August 27, 1928 (*F. Rivera and A. C. Duyag*). Other Philippine records: Lawa, Davao district, Mindanao, at light, April 24, 1930 (*C. F. Clagg*); Calian, Mindanao, July 12, 1930, at light (*C. F. Clagg*).

[3] Philip. Journ. Sci. § D 12 (1917) 115.
[4] Notulae Entomologicae 6 (1926) 34.

STYRINGOMYIA NEOCOLONA sp. nov. Plate 3, fig. 45.

Closely allied to *colona;* general coloration yellow, the præscutum with black lines behind; blackened areas on femora and tibiæ restricted in area; male hypopygium with the apical lobe of the tergite truncate; ninth sternite expanded at apex and deeply emarginate.

Male.—Length, about 6 millimeters; wing, 4.3.

Rostrum brown; palpi brownish yellow, the outer segment paling to yellow. Antennæ with the basal segment black above, the remainder of organ pale yellow. Head light brown.

Pronotum restrictedly pale medially, blackened laterally. Mesonotal præscutum obscure brownish yellow; marked with black behind, including two submedian black lines that converge in front, inclosing an oval ocherous median area before the suture; scutal lobes similarly ocherous, bordered externally by black; scutellum obscure yellow, margined caudally by black; postnotal mediotergite black. Pleura yellow. Halteres yellow. Legs with the coxæ and trochanters pale yellow; femur yellow. with two small black spots on upper surface only; tibiæ yellow, the tips blackened, with an additional restricted black cloud on upper surface before midlength; tarsi yellow, the terminal segment blackened. Wings pale yellow, with four blackish areas, as usual in the genus, these on anterior cord, m and adjoining veins, m-cu, and on the distal two-fifths of vein 2d A; veins yellow, blackened in the dark areas. Venation: Anterior branch of Rs normally oblique; m short but present, cell 2d M_2 being short-sessile; vein 2d A curved into the anal margin, the cell relatively wide.

Abdominal tergites yellow, the segments with two small brown spots on caudal margin, those of the second segment large, of segments three to five small, on the outer segments again becoming larger and confluent; sternites and hypopygium yellow. Male hypopygium (Plate 3, fig. 45) with the apical lobe of the tergite, 9*t*, elongate, gradually narrowed outwardly, the apex truncate. Ninth sternite, 9*s*, very slender, expanded outwardly, the apex deeply bilobed by a U-shaped notch, the slender lobes with two long setæ, one apical, the second placed more laterally at base. Basistyle, *b*, with the apical spinous seta a little shorter than its long basal tubercle. Dististyle, *d*, complex, the outer arm at apex produced mesad at a right angle into a long blackened spike, with a smaller curved black spine at bend of outer margin; intermediate arm smaller but of somewhat similar shape

to the outer arm; inner arm long, armed with groups of spines as illustrated.

In *colona* (Plate 3, fig. 46) the apical lobe of the tergite, *9t*, is slightly longer, with the end gently emarginate. Ninth sternite, *9s*, with the lateral margins straight, the apex more gently emarginate. Outer arm of dististyle, *d*, without a curved black spine at angle; inner arm of very different conformation, as shown.

MINDANAO, Davao district, Calian, July 16, 1930 (*C. F. Clagg*); holotype, male.

The distinctions between the present species and *Styringomyia colona* Edwards (Krakatau) are best shown in the structure of the male hypopygium.

ILLUSTRATIONS

[Legend: *a*, ædeagus; *b*, basistyle; *d;* dististyles; *db*, dorsal lobe of basistyle; *dd*, dorsal dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *s*, 9th sternite; *t*, 9th tergite; *vb*, ventral lobe of basistyle; *vd;* ventral dististyle.]

PLATE 1

FIG. 1. *Dolichopeza* (*Mitopeza*) *rizalensis* sp. nov., wing.
2. *Dolichopeza* (*Nesopeza*) *melanosterna* sp. nov., wing.
3. *Dolichopeza* (*Nesopeza*) *tarsalis* Alexander, wing, medial field.
4. *Dolichopeza* (*Mitopeza*) *mjöbergi* Edwards, wing, medial field.
5. *Limonia* (*Limonia*) *bilobulifera* sp. nov., wing.
6. *Limonia* (*Limonia*) *melanopleura* sp. nov., wing.
7. *Limonia* (*Limonia*) *tremula* sp. nov., wing.
8. *Limonia* (*Libnotes*) *unistriolata* sp. nov., wing.
9. *Limonia* (*Libnotes*) *melancholica* sp. nov., wing.
10. *Limonia* (*Libnotes*) *perrara* sp. nov., wing.
11. *Limonia* (*Dicranomyia*) *orthia* sp. nov., wing.
12. *Limonia* (*Dicranomyia*) *neopunctulata* sp. nov., wing.
13. *Helius* (*Eurhamphidia*) *fuscofemoratus* sp. nov., wing.
14. *Helius* (*Eurhamphidia*) *indivisus* sp. nov., wing.
15. *Trentepohlia* (*Mongoma*) *distalis* sp. nov., wing.
16. *Gonomyia* (*Progonomyia*) *terebrella* sp. nov., wing.
17. *Erioptera* (*Teleneura*) *melanotænia* sp. nov., wing.
18. *Erioptera* (*Empeda*) *lunensis* sp. nov., wing.
19. *Molophilus banahaoensis* sp. nov., wing.
20. *Molophilus procericornis* sp. nov., wing.
21. *Styringomyia armata* Edwards, wing.
22. *Styringomyia claggi* sp. nov., wing.

PLATE 2

FIG. 23. *Dolichopeza* (*Mitopeza*) *rizalensis* sp. nov., male hypopygium.
24. *Dolichopeza* (*Nesopeza*) *melanosterna* sp. nov., male hypopygium.
25. *Limonia* (*Limonia*) *bilobulifera* sp. nov., male hypopygium.
26. *Limonia* (*Limonia*) *melanopleura* sp. nov., male hypopygium.
27. *Limonia* (*Libnotes*) *unistriolata* sp. nov., male hypopygium.
28. *Limonia* (*Libnotes*) *melancholica* sp. nov., male hypopygium.
29. *Limonia* (*Dicranomyia*) *orthia* sp. nov., male hypopygium.
30. *Limonia* (*Dicranomyia*) *neopunctulata* sp. nov., male hypopygium.
31. *Limonia* (*Dicranomyia*) *punctulata* de Meijere, male hypopygium.
32. *Limmonia* (*Dicranomyia*) *fullowayi* Alexander, male hypopygium.
33. *Helius* (*Eurhamphidia*) *indivisus* sp. nov., male hypopygium.
34. *Erioptera* (*Teleneura*) *melanotænia* sp. nov., male hypopygium.

PLATE 3

FIG. 35. *Erioptera (Empeda) lunensis* sp. nov., male hypopygium.
36. *Molophilus banahaoensis* sp. nov., male hypopygium.
37. *Molophilus procericornis* sp. nov., male hypopygium.
38. *Molophilus mendicus* sp. nov., male hypopygium.
39. *Molophilus tawagensis* sp. nov., male hypopygium.
40. *Styringomyia luteipennis* sp. nov., male hypopygium.
41. *Styringomyia montina* sp. nov., male hypopygium.
42. *Styringomyia armata* Edwards, male hypopygium.
43. *Styringomyia claggi* sp. nov., male hypopygium.
44. *Styringomyia nigrosternata* sp. nov., male hypopygium.
45. *Styringomyia neocolona* sp. nov., male hypopygium.
46. *Styringomyia colona* Edwards, male hypopygium.

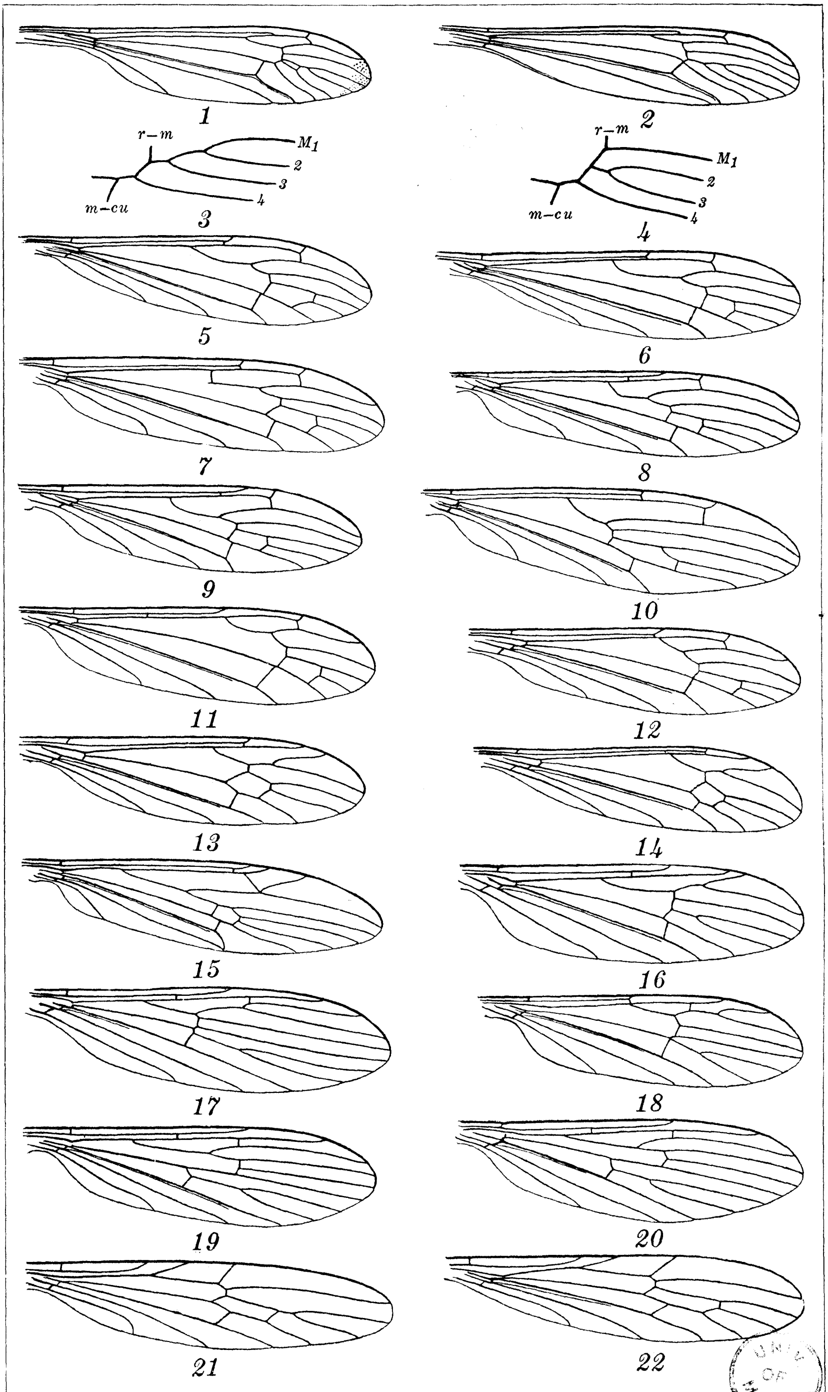
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PLATE 1.

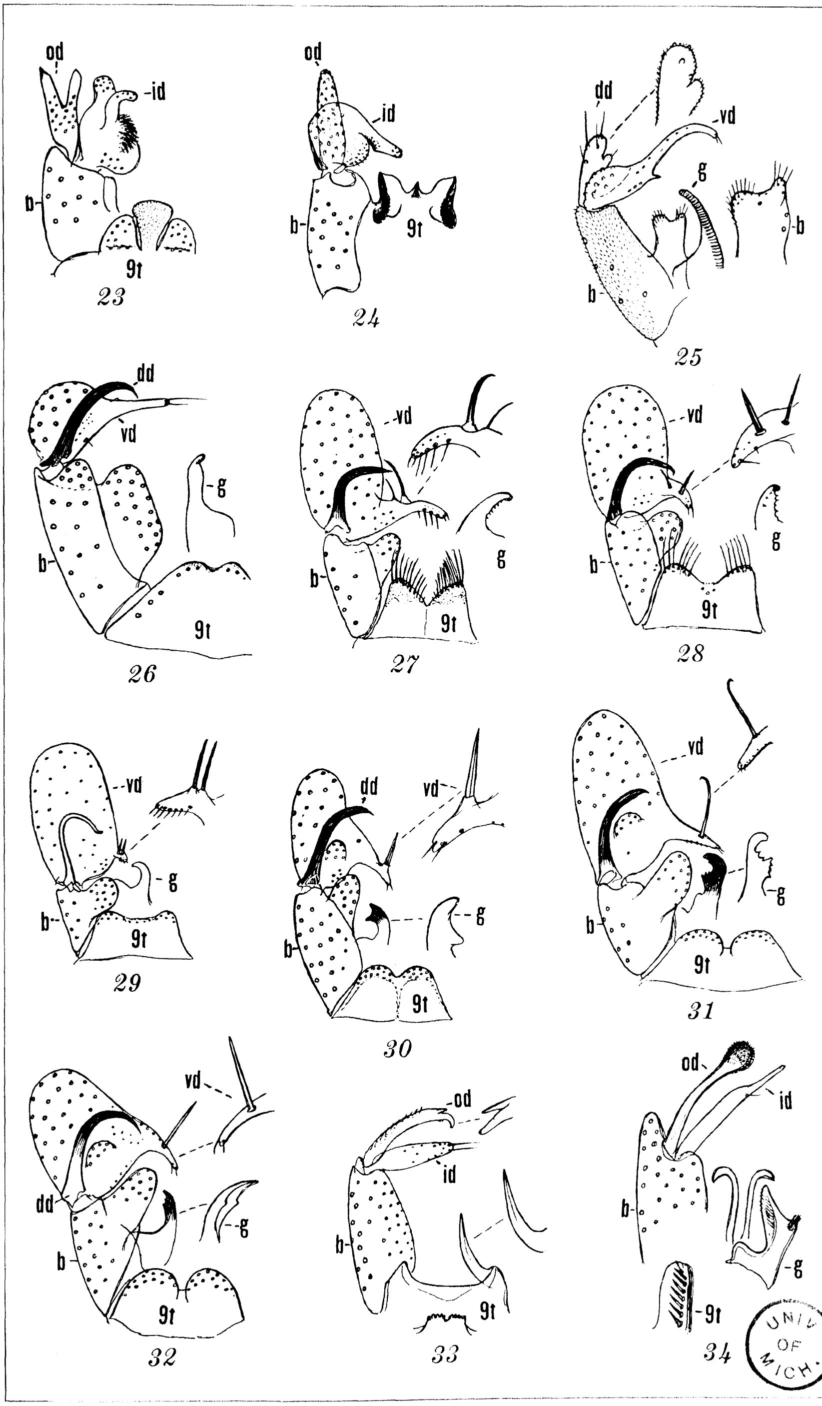
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PLATE 2.

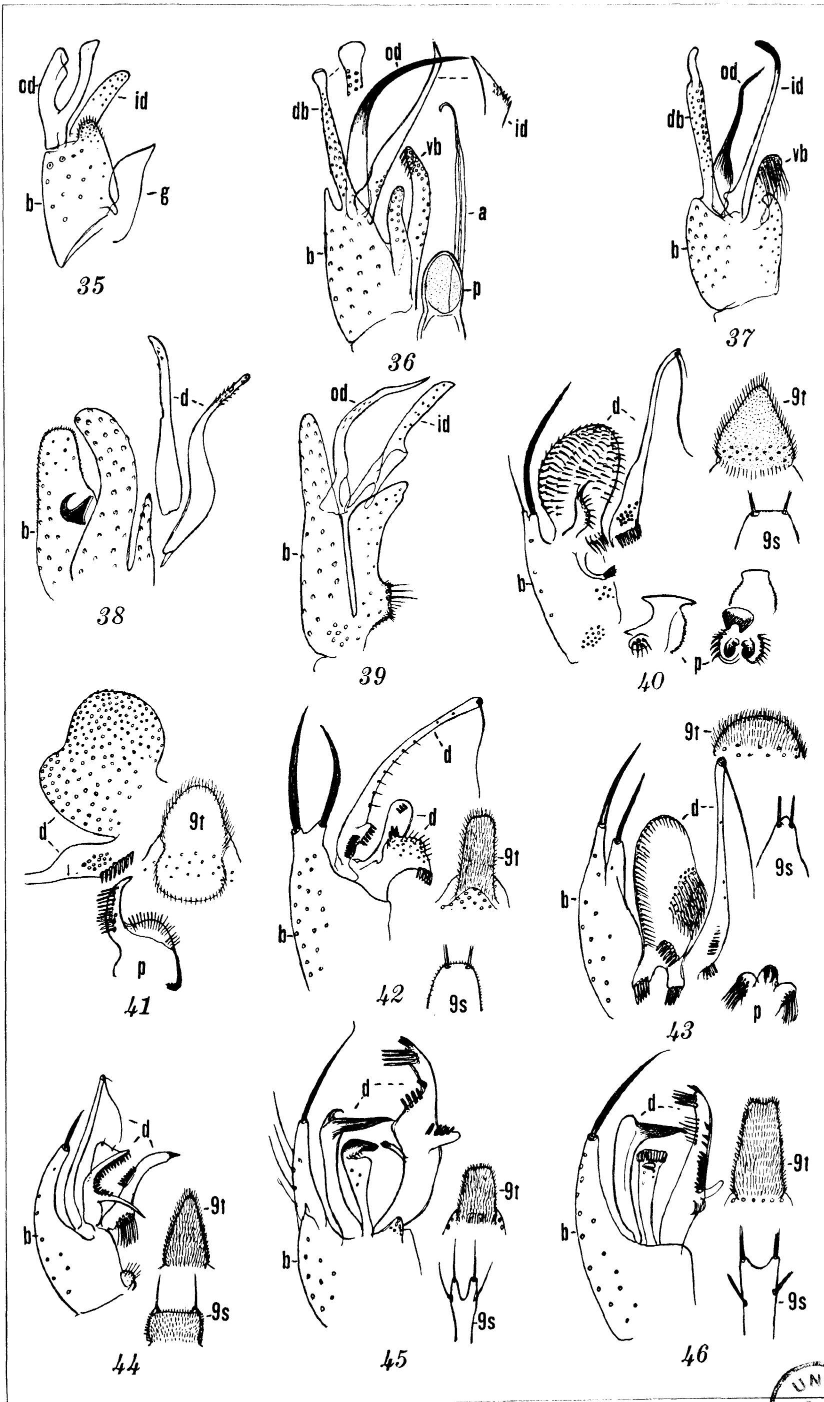

PLATE 3.

THE PHILIPPINE JOURNAL OF SCIENCE

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AVIAN MALARIA STUDIES, I

PROPHYLACTIC PLASMOCHIN IN INOCULATED AVIAN MALARIA [1]

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Of the International Health Division, Rockefeller Foundation

TWENTY TEXT FIGURES

INTRODUCTION

The drug plasmochin, sometimes spelled plasmoquine, was developed in Germany in the Elberfeld laboratories of the I. G. Farbenindustrie in 1926 by the chemists Hörlein,(65, 66) Schulemann, Wingler, and Schönhofer(158) working in close coöperation with Roehl,(149, 151) who used canaries as his experimental animals. In the five years since then a great deal of attention has been given this synthetic product in many laboratories throughout the world. In the accompanying bibliography are listed 194 plasmochin references and the list is not complete as to Continental and South American periodicals. It is rather remarkable that among these numerous publications there appear to be only three that refer to the possibility of using plasmochin to prevent malaria infection in man or birds.

[1] In the examination of blood smears in the experiments reported in parts I to IV of this series the author was assisted by Misses Amparo Capistrano and Filomena Villacorta, microscopists on the staff of malaria investigations of which the author is chief. This organization is supported by the Bureau of Science, Manila, in coöperation with the International Health Division of the Rockefeller Foundation. The experiments were done at the Bureau of Science. This article was submitted for publication February 17, 1931.

Hegner and Manwell (60) by administering plasmochin to birds in daily oral doses of 1.5 milligrams kept the blood of one bird free from parasites for forty days after inoculation "with one possible exception." Daily oral doses of 1.0 and 0.5 milligram for five days after a single inoculation did not prevent the appearance of parasites in the blood of birds.

Fischer (48) reported using plasmochin as a prophylactic drug in man. He gave plasmochin to the crew of a ship calling at West African river ports, and although he had 15 per cent malaria morbidity, he contrasts this with 30 per cent on two similar ships. Ejercito (44) in the Philippines gave prophylactic plasmochin compound to eight individuals and prophylactic quinine to eight others. Two of the first group and six of the second acquired malaria during an eight weeks' test during which they were not under strict control. He concluded that plasmochin compound is apparently efficacious when used as a prophylactic against malaria and maintains more subjects negative to malaria than quinine alone. He gave daily doses of 0.01 gram of plasmochin combined in tablet form with 0.125 gram quinine sulphate to the first group and 10 grains of quinine sulphate daily to the second.

A number of references may be found to a tendency that plasmochin seems to have to attack gametocytes in such a way that they become devitalized and noninfective to mosquitoes. Consult, for example, Roehl; (149, 151) Green; (56) Manson-Bahr; (97, 98) Barber, Komp, and Newman; (11) and Whitmore, Roberts, and Jantzen. (193) There seems to be no doubt that plasmochin has a genuine usefulness in malaria therapy, although the tendency is to recommend that it be combined with quinine for greater safety and effectiveness; consult, for example, Green, (56) Manson-Bahr, (97, 98) and Sinton. (165)

The paucity and yet suggestiveness of the evidence as regards prophylactic properties of plasmochin led to the experiments reported in this paper.

GENERAL PROCEDURE

In the experiments here reported female canaries (*Serinus canarius*) were used. These birds were purchased from local dealers and were susceptible to the plasmodium involved. Female birds were used because they cost less than males. The parasite, *Plasmodium cathemerium* (Hartman, 1927), in over two hundred cases has invariably established itself in these

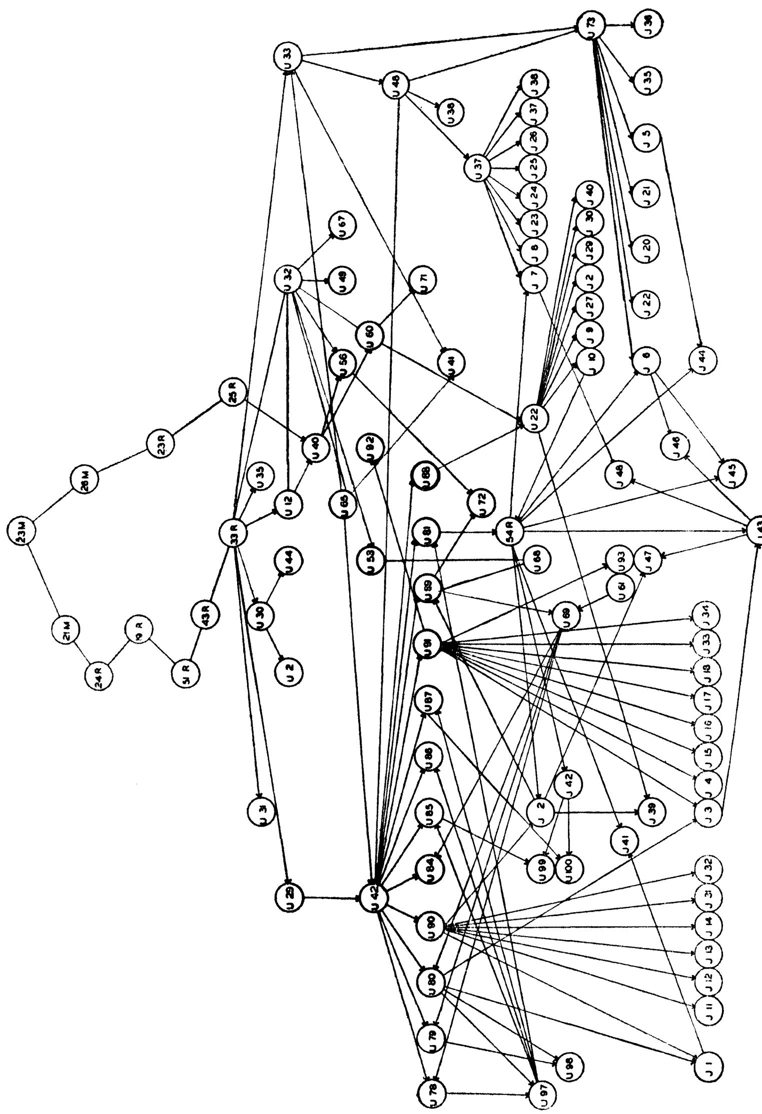

FIG. 1. Lines of transmission and attempted transmission of *Plasmodium cathemerium*. Experiments 1 to 4.

birds upon injection, except during the periods of plasmochin administration as noted below. This parasite was obtained through the courtesy of Dr. C. G. Huff and is his "Boston strain." It is not in direct line from the original isolation by Hartman in 1924 from a Baltimore sparrow but was taken by Huff from a Boston sparrow. The same strain of parasite was used in all of the experiments reported in this and the second paper of this series. The lines of transmission are shown in fig. 1. All birds were kept well screened.

TECHNIC OF BLOOD INOCULATIONS

The technic of inoculation is simple. A vein on the inner side of the left leg of the donor bird is punctured gently with a Hagedorn needle, and blood is drawn into a 1-cubic-centimeter tuberculin syringe half full of physiologic saline solution. After each drop or two of blood is drawn into the syringe some of the resulting mixture is ejected into a small vial that also contains a little of the saline solution. By repeating this process one soon has 1 or 2, or even 3, cubic centimeters, as required, of a bright pink mixture of blood and saline solution, which is thoroughly mixed. Using a 27-gauge needle, an injection (in these experiments) of 0.3 cubic centimeter of the mixture was made into the left breast muscle of the recipient bird. It is possible also to infect birds by intraperitoneal and intravenous routes, but in these experiments only intramuscular injections were made.

USUAL COURSE OF INFECTION

After a prepatent period, which with *P. cathemerium* is usually from four to seven days, smears of the peripheral blood as a rule show parasites in small numbers for three or four days and then in great numbers for four or five days. If death does not occur the blood stream then rapidly becomes relatively free from parasites, but the blood usually remains infective during the life of the bird, even over a period of years. Only occasionally can parasites be demonstrated in smears; but in this chronic or latent stage, even when parasites cannot be demonstrated by prolonged microscopical examination, the blood remains infective. Consult, for example, Wasielewski,(189) Sergent and Sergent, (160) and Whitmore;(192) or take the case of bird X36 in one of my experiments, typical of others in the series. This bird became positive nine days after receiving an injection of 0.3 cubic centimeter of blood-saline mixture

taken as described above, from bird J53. A 30-minute examination of a blood smear from this donor bird (J53) taken the day before, again at the time it was being bled for the inoculation of X36, and the next day, showed no parasites at all.

SUPERINFECTION

If a bird be reinoculated with the same strain of plasmodium there is no superinfection. The bird is immune to a new infection of any given strain so long as it has a chronic infection, and this, in most cases, means for the rest of its life. If, however, the bird becomes entirely free of the plasmodium in question it can be reinfected. This phenomenon of immunity to superinfection with the same species of plasmodium is well known to all who have studied avian malaria. Consult, for example, Wasielewski,(189) Moldovan,(115) Sergent and Sergent,(160) and Taliaferro and Taliaferro.(175)

In these experiments this fact of immunity to superinfection was used as a test to prove that the plasmochin-protected birds were actually free from the plasmodium injected into their muscle. Had they been carrying parasites hidden from blood-smear examination they would have been immune to subsequent inoculations with the same strain of plasmodium.

ADMINISTRATION OF PLASMOCHIN

The drug as used in these experiments was plasmochin simplex, manufactured by I. G. Farbenindustrie A. G., Leverkusen, Germany, for the Winthrop Chemical Company, Inc., New York. It was purchased at a local pharmacy in boxes of ten ampoules of 1 cubic centimeter each. According to the label the ampoules contained a 1 per cent solution of plasmochin simplex, *N*-diethyl-amino-isopentyl-8-amino-6-methoxy-quinoline. In other words 1 cubic centimeter of the solution contained 0.01 gram of plasmochin. To 1 cubic centimeter of this solution were added 4 cubic centimeters of distilled water. Thus, 5 cubic centimeters of the resulting solution contained 0.01 gram of plasmochin. In the first two experiments reported here, 0.1 cubic centimeter of this diluted solution was used as a daily dose; that is, 0.0002 gram of plasmochin simplex. This was given intramuscularly in the right breast, on the opposite side to that used for the parasite inoculation.

In the third experiment here recorded and in a fourth described in the second paper of this series the dose of plasmochin simplex was 0.00016 gram.

In some cases in the first two experiments there was necrosis at the site of injection; but by making the injections well anterior to avoid hæmatomata and by inserting the needle deep in the muscle and holding it steady during the injection, necrosis was prevented in the last two experiments and the birds tolerated the injections very well.

In the first two experiments the mortality for a period of ten days after the first injection of plasmochin among the twenty-one birds used was 71 per cent. In the eleven control birds (receiving no plasmochin) during the same period it was 45 per cent. In the last two experiments with improved technic, a smaller dose of plasmochin, and probably a stronger lot of birds, the mortality for ten days in the twenty birds receiving plasmochin was 15 per cent and in the control group of fourteen birds it was 29 per cent (see Tables 1 and 2).

TABLE 1.—*Mortality in first, second, and third experiments.*

	Number of birds.	Died in 10 days or less.		Died in 15 days or less.		Died in 30 days or less.		Alive after 176 days or more.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
First experiment:									
Plasmochin series	6	3	50	4	67	5	83	1	7
Controls	7	3	43	4	57	7	100	0	0
Total	13	6	46	8	62	12	92	1	8
Second experiment:									
Plasmochin series	15	12	80	13	87	14	93	(b)	------
Controls	4	2	50	3	75	3	75	(c)	------
Total	19	14	74	16	84	17	89	------	------
Third experiment:									
Plasmochin series [a]	10	2	20	2	20	4	40	1	10
Controls	4	0	0	0	0	2	50	2	50
Total	14	2	14	2	14	6	43	3	21
Totals for three experiments:									
Plasmochin series	31	17	55	19	61	23	74	2	6
Controls	15	5	33	7	47	12	80	2	3
Total	46	22	48	26	57	35	76	4	9

[a] Six lived more than forty-five days.
[b] One lived thirty-four days.
[c] One lived seventy-seven days.

TABLE 2.—*Mortality, first and second versus third and fourth experiments.*

	Number of birds.	Died in 10 days or less.		Died in 15 days or less.		Died in 30 days or less.		Alive after 170 days or more.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Plasmochin series:									
First and second experiments	21	15	71	17	81	19	20	1	5
Third and fourth experiments	20	3	15	3	15	7	35	5	25
Total	41	18	44	20	49	26	63	6	15
Controls:									
First and second experiments	11	5	45	7	63	10	90	0	0
Third and fourth experiments	14	4	29	5	36	10	71	4	29
Total	25	9	36	12	48	20	80	4	16
Totals:									
First and second experiments	32	20	63	24	75	29	91	1	3
Third and fourth experiments	34	7	21	8	42	17	50	9	26
Total	66	27	41	32	48	46	70	10	15

The size of the dose was determined by the fact that 0.0002 gram was the largest amount of plasmochin simplex which would not cause signs of drug absorption in canaries. Increasing the dosage caused signs beginning with unsteadiness of gait and progressing as the dose became larger to coma and death. (See the second paper of this series for a discussion of the minimum lethal dose.)

BLOOD EXAMINATION

Blood smears were stained with Giemsa's stain and were examined until a parasite was seen or, if none was seen, up to a total of thirty minutes. If no parasites were found in thirty minutes, the slide was called negative. If positive, it was classified in accordance with the following scheme:

- \+ Positive in thirty minutes or less.
- ++ Two parasites per field found more than twice in one minute.
- +++ Three parasites per field found more than three times in one minute.
- ++++ Four parasites per field found more than four times in one minute.
- +++++ Ten or more parasites per field on the average.

This practical method of classification is suitable for this experiment. The fact that it is a fairly good grouping may be seen from Table 3, which also serves to present evidence as to the approximate meaning of the plus signs.

TABLE 3.—*Intensity grouping of blood smears.*

Group.	Number of smears counted.	Parasites counted per 10,000 red blood cells.
+	74	15
++	19	170
+++	18	320
++++	15	560
+++++	44	1,320

FIRST EXPERIMENT (JUNE 19 TO JULY 21, 1930)

In the first experiment, as shown in fig. 2, plasmochin injections were started in six birds, U3, U12, U27, U28, U29, and U33. Of these, only three, U12, U33, and U29, lived beyond the first ten days of the experiment. There were seven controls, U2, U25, U30, U31, U32, U34, and U35, of which two, U25 and U34, died within ten days. The others all developed typical infections. Of the three birds receiving plasmochin two, U12 and U29, died before they could be proved susceptible to malaria. In the case of U12 blood was taken ten days after the attempt to infect it. This blood proved to be noninfective to bird U40, which twenty-seven days later was proved to be susceptible to the same species of plasmodium. In the case of U29 blood was taken eight days after the attempt to infect it. This blood proved to be noninfective to U42, which twenty-seven days later was proved to be a susceptible bird.

There follow the protocols of U12, U33, and U29, which are illustrated in figs. 3, 4, and 5.

FIRST EXPERIMENT

Protocol 1. Bird U12.

June 19, 1930. Blood smear negative from *U12* (30 minutes).

June 28. Blood smear negative from *U12* (30 minutes).

June 30 to July 6. *U12* received 0.0002 gram plasmochin simplex by intramuscular injection each day into right breast.

July 2. *U12* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird 33R, known to be infective.

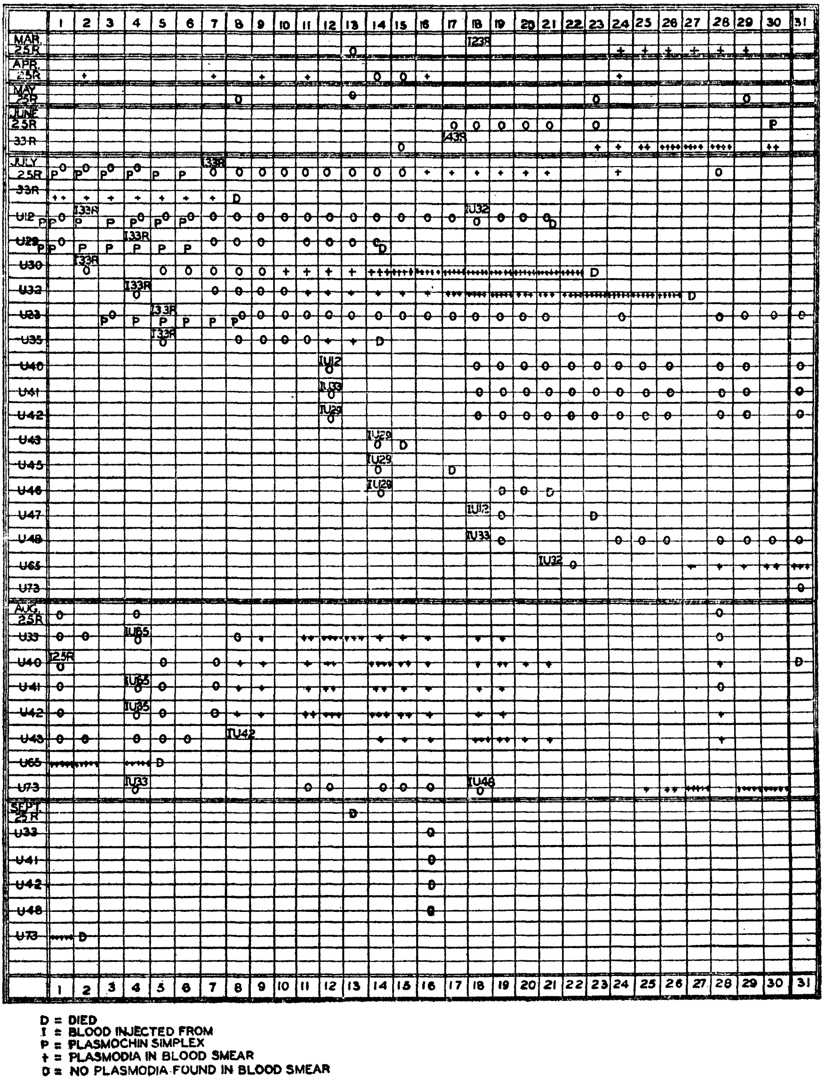

FIG. 2. Plasmochin simplex, a prophylactic drug in avian malaria. First experiment.

An equal amount of the same mixture was given at the same time to bird U30, as a control. Both injections made into left breast muscle. Control bird, U30, became + July 10 and died July 23 of severe malaria.

July 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, and 21. Daily blood smears from *U12* negative. (Each smear searched for 30 minutes.)

July 12. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U12* injected into U40 which had

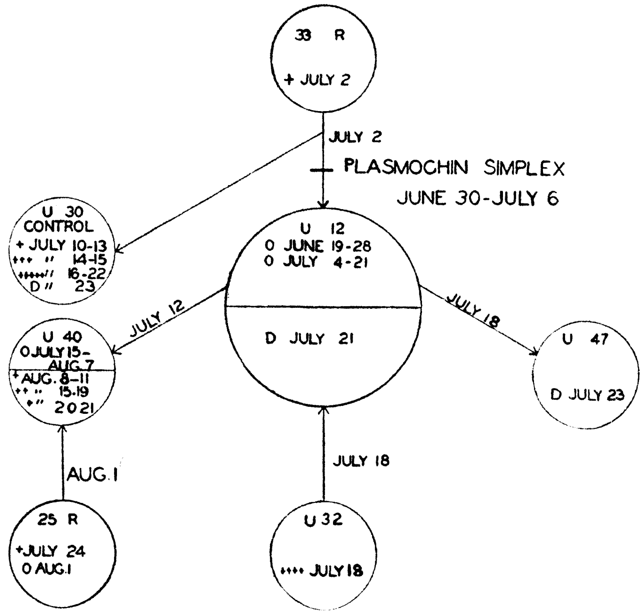

FIG. 3. Bird U12.

negative blood smears July 12, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, and 31, and August 1, 5, and 7. U40 became + August 8, which was seven days after injection from bird 25R, which was known to be infective.

July 18. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U12* injected into U47, which died July 23. (Of no value in this experiment.)

July 18. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from bird U32, which was known to be infective, injected into *U12*.

July 21. *U12* died with no evidence of malaria.

Protocol 2. Bird U29.

June 30, 1930. Blood smear from *U29* negative (30 minutes).

July 1. Blood smear from *U29* negative (30 minutes).

June 30 to July 6. *U29* received 0.0002 gram plasmochin simplex by intramuscular injection each day into right breast.

July 4. *U29* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird 33R, known to be infective. An equal amount of the same mixture was given at the same time to bird U32, as a control. Both injections were made into left-breast muscle. The control bird, U32, became + July 11 and died July 26 after severe malaria.

July 7, 8, 9, 11, 12, 13, and 14. Daily blood smears from *U29* negative. (Each smear searched for 30 minutes.)

July 12. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from *U29* injected into U42, which had neg-

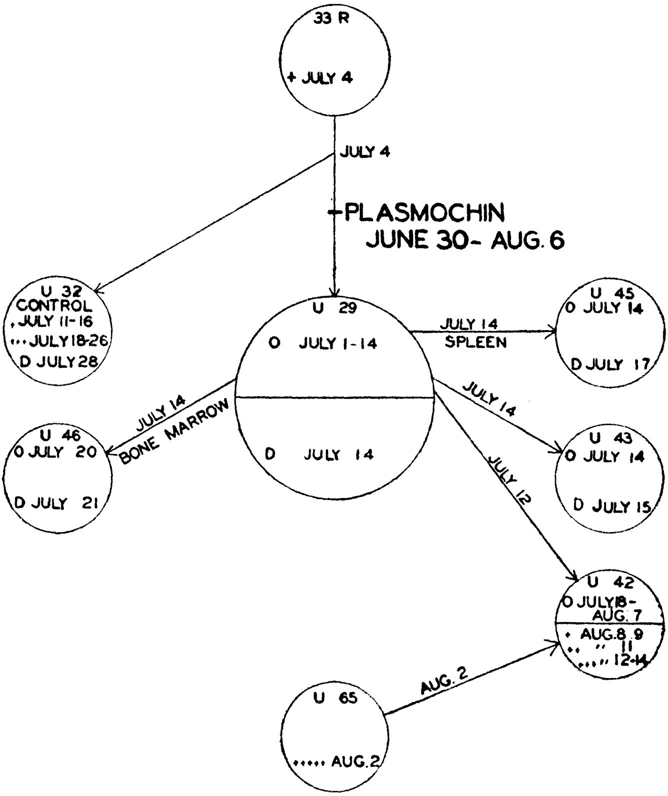

FIG. 4. Bird U29.

ative blood smears July 12, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, and 31, and August 1, 4, 5, and 7. U42 became + August 8, which was four days after injection from bird U65, which was known to be positive.

July 14. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from *U29* injected into U43, which died July 15. (Of no value in this experiment.)

July 14. *U29* died.

Physiologic saline mixture of bone marrow from *U29* injected into U46, whose blood smear was negative July 20 and which died July 21.

Physiologic saline mixture of spleen pulp from *U29* injected into U45, which died July 17. (Of no value in this experiment.)

Protocol 3. Bird U33.

July 3, 1930. Blood smear from *U33* negative (30 minutes).

July 3 to 8. *U33* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

July 5. *U33* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird 33R, known to be infective. An equal amount of the same mixture was given at the same time to bird

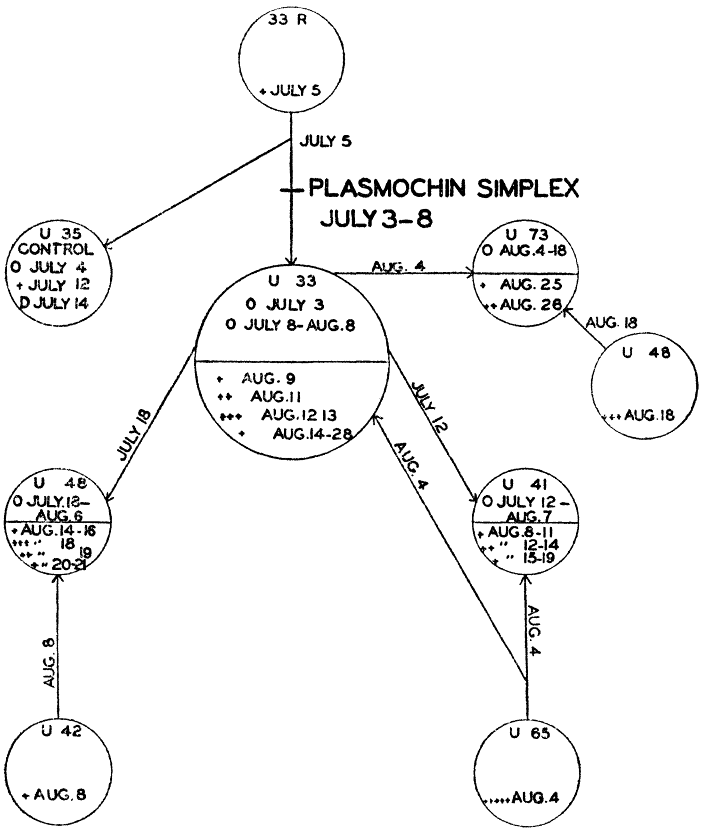

FIG. 5. Bird U33.

U35, as control. All injections were made into left breast muscle. U35 became positive July 12 and died July 14 of severe malaria.

July 8, 9, 10, 11, 12, 13, 14, 15, 16, 24, 28, 29, 30, and 31, and August 1, 2, 4, and 8. Daily blood smears from *U33* negative. (Each smear searched for 30 minutes.)

July 12. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U33* injected into U41, which had negative blood smears July 12 to August 7. U41 became positive August 8, which was four days after injection from U65, which was known to be positive.

July 18. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U33* injected into U48, which had negative blood smears July 19 to August 6. U48 became positive August 14, which was six days after injection from U42, which was known to be positive.

August 4. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U33* injected into U73, which had negative blood smears July 31 to August 18. U73 became positive

August 25, which was seven days after injection from U48, which was known to be positive.

August 4. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U65, known to be infective, injected into *U33*.

August 9, *U33* +; August 11, *U33* ++; August 12 and 13, *U33* +++; August 14 to 28, *U33* +; October 11, *U33* +.

SECOND EXPERIMENT (JULY 19 TO AUGUST 24, 1930)

Encouraged by the one clear-cut success in the first experiment, a series of fifteen birds, U50 to U64, were given plasmochin simplex in 0.0002 gram intramuscular doses, as described above, every day for seven days. Infected blood was injected into these birds and into four control birds, U7, U65, U66, and U67, on the third day. Two of the controls, U7 and U66, and ten of the birds receiving plasmochin, U50 to U52, U57 to U59, and U62 to U64, died within ten days and were of no value in the experiment. The other two controls had typical malaria infections (see fig. 6).

Of the five remaining birds receiving plasmochin two, U56 and U60, lived thirty-five and thirty-one days, respectively; long enough to give clear-cut results. The other three died before they could be proved to be susceptible. None showed any evidence whatever of malaria after thirteen, thirteen, and fourteen days, respectively. In the case of U53 and U61 blood was taken on the ninth day after attempted infection. This blood proved to be noninfective when injected into birds that in each case were proved to be susceptible twenty-eight days later.

The protocols of U53, U54, U56, U60, and U61 follow. These protocols are illustrated in figs. 6 to 10, inclusive.

SECOND EXPERIMENT

Protocol 1. Bird U53.

July 19, 1930. Blood smear from *U53* negative (30 minutes).

July 19 to 24. *U53* received 0.0002 gram plasmochin simplex by intramuscular injection each day about 10 a. m. into right breast.

July 21. *U53* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from U32, known to be infective. An equal amount of the same mixture was given at the same time to birds U64, U65, U66, and U67, as controls. All injections were made into left breast muscle about 3 p. m. Control bird U64 died, negative, July 26; U65 became + July 27 and died August 5 of severe malaria; U66 died, negative, July 27; U67 became + July 27 and had a mild infection.

July 28, 29, 30, and 31. Daily blood smears from *U53* negative. (Each smear searched for 30 minutes.)

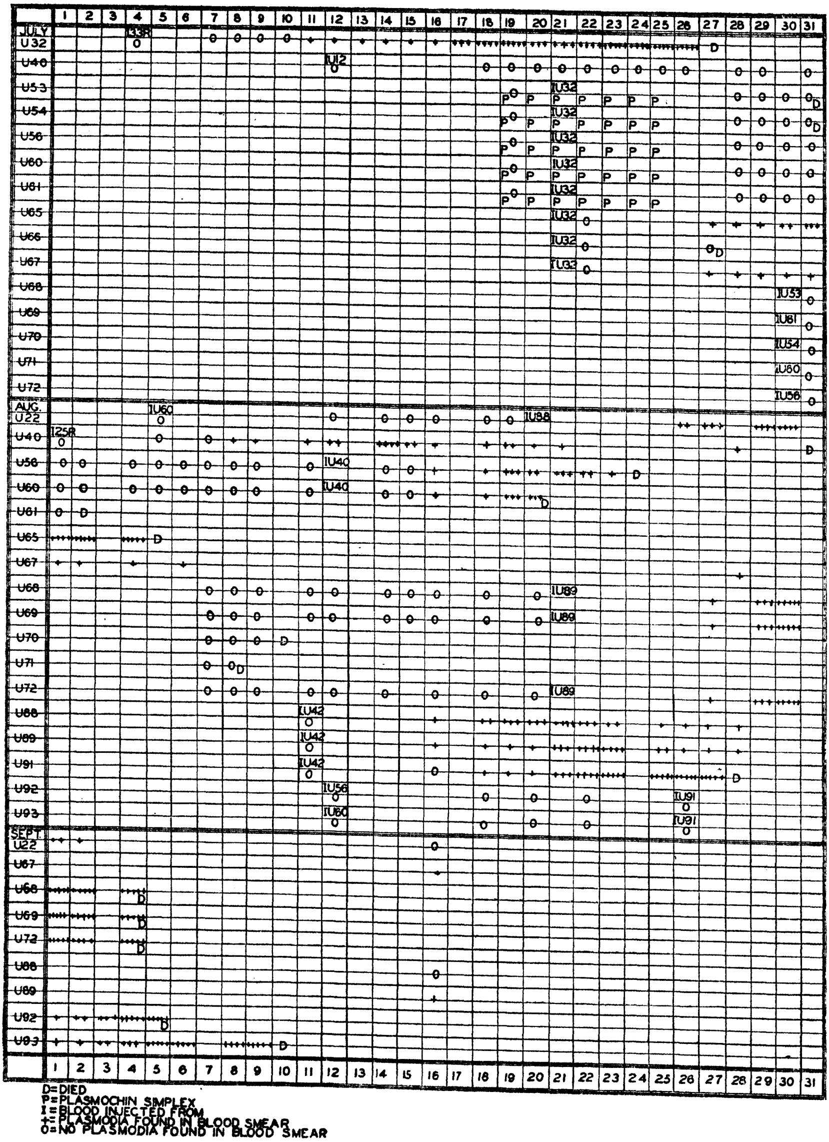

FIG. 6. Plasmochin simplex, a prophylactic drug in avian malaria. Second experiment.

July 30. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U53* injected into U68, which had negative blood smears July 31, and August 7, 8, 9, 11, 12, 14, 15, 16, 18, and 20. U68 became + August 27, which was six days after injection from bird U89, which was known to be infective.

July 31. *U53* died with no evidence of malaria.

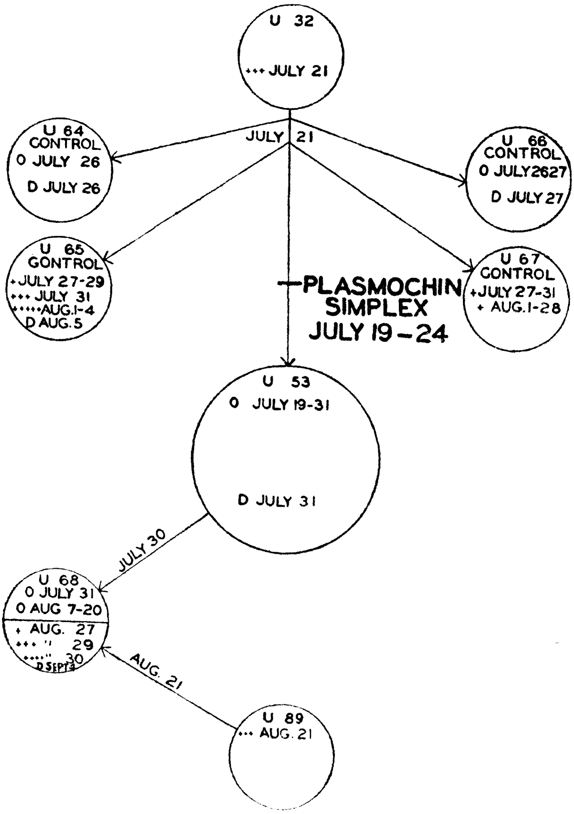

FIG. 7. Bird U53.

Protocol 2. Bird U54.

July 19, 1930. Blood smear from *U54* negative (30 minutes).

July 19 to 24. *U54* received 0.0002 gram plasmochin simplex by intramuscular injection each day about 10 a. m. into right breast.

July 21. *U54* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U32, known to be infective. An equal amount of the same mixture was given at the same time to birds U64, U65, U66, and U67, as controls. All injections were made into left breast muscle about 3 p. m. Control bird U64 died, negative, July 26; U65 became + July 27 and died August 5 of severe malaria; U66 died, negative, July 27; U67 became + July 27 and had a mild infection.

July 28, 29, 30, and 31. Daily blood smears from *U54* negative. (Each smear searched for 30 minutes.)

July 30. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U54* injected into U70, which was negative August 7, 8, and 9 and died August 10 with no evidence of malaria.

July 31. *U54* died with no evidence of malaria.

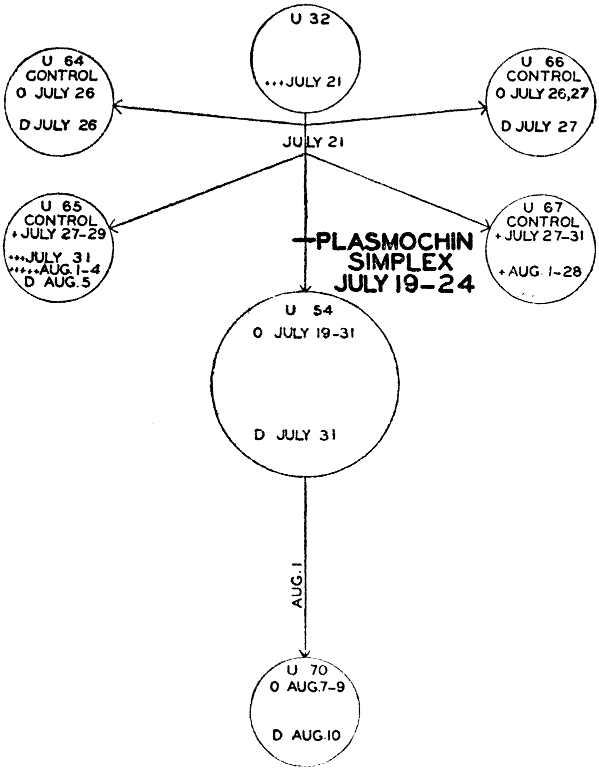

FIG. 8. Bird U54.

Protocol 3. Bird U56.

July 19, 1930. Blood smear from *U56* negative (30 minutes).

July 19 to 24. *U56* received 0.0002 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

July 21. *U56* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U32, known to be infective. An equal amount of the same mixture was given at the same time to birds U64, U65, U66, and U67, as controls. All injections were made into left breast muscle. U65 and U67 became positive July 27. U64 and U66 died July 26 and 27, respectively.

July 28, 29, 30, and 31, and August 1, 2, 4, 5, 6, 7, 8, 9, 11, 14, and 15. Daily blood smears from *U56* negative. (Each smear searched for 30 minutes.)

July 30. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U56* injected into U72, which had negative blood smears July 31 to August 20. U72 became positive August 27, which was six days after injection from U89, which was known to be positive.

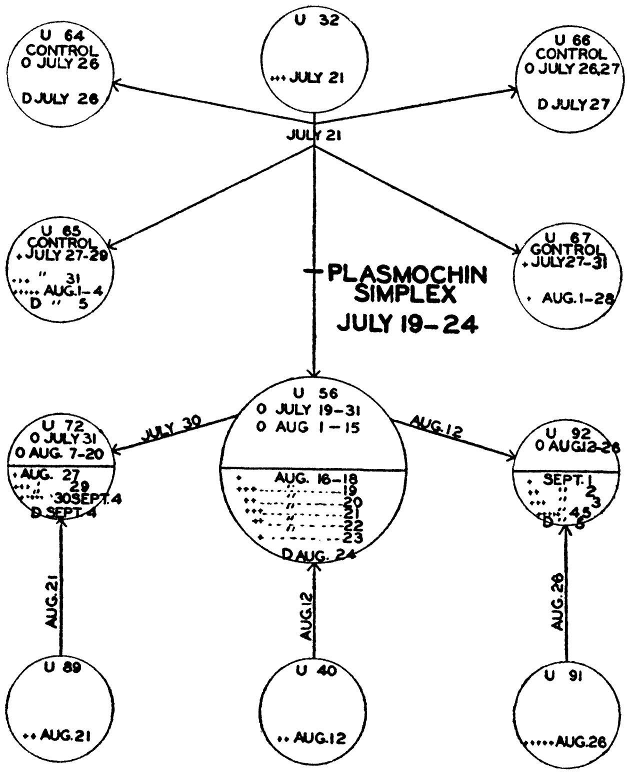

FIG. 9. Bird U56.

August 12. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U56* injected into U92, which had negative blood smears August 12 to 26. U92 became positive September 1, which was six days after injection from U91, which was known to be positive.

August 12. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U40, known to be infective, injected into *U56*.

August 16 and 18, *U56* +; August 19, *U56* +++; August 20, *U56* ++; August 21, *U56* +++; August 22, *U56* ++; August 23, *U56* +; August 24, died.

Protocol 4. Bird U60.

July 19, 1930. Blood smear from *U60* negative (30 minutes).

July 19 to 24. *U60* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

July 21. *U60* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U32, known to be infective. An equal amount of the same mixture was given at the same time to birds

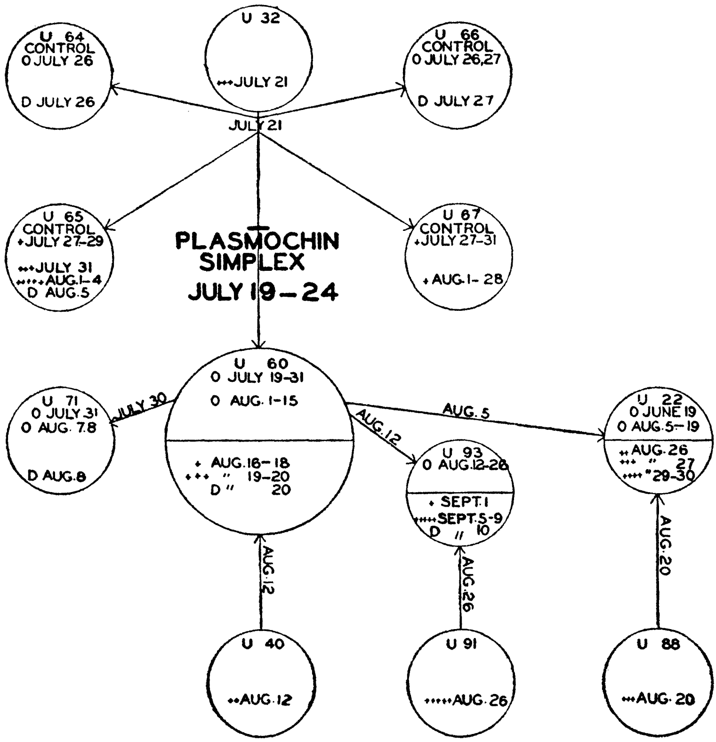

FIG. 10. Bird U60.

U64, U65, U66, and U67, as controls. All injections were made into left breast muscle. U65 and U67 became positive July 27. U64 and U66 died July 26 and 27, respectively.

July 28, 29, 30, and 31, and August 1, 2, 4, 5, 6, 7, 8, 9, 11, 14, and 15. Daily smears from *U60* negative. (Each smear searched for 30 minutes.)

July 30. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U60* injected into U71, which had negative blood smears August 7 and 8 and died August 8.

August 5. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U60* injected into U22, which had negative blood smears June 19 to August 19. U22 became positive August 26, which was six days after injection from U88, which was known to be positive.

August 12. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U60* injected into U93, which had negative blood smears August 12 to 26. U93 became positive September 1, which was six days after injection from U91, which was known to be positive.

August 12. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U40, known to be infective, injected into *U60*.

August 16 and 18, *U60* +; August 19 and 20, *U60* +++; August 20, *U60* died.

Protocol 5. Bird U61.

July 19, 1930. Blood smear from *U61* negative (30 minutes).

July 19 to 24. *U61* received 0.0002 gram plasmochin simplex by intramuscular injection each day about 10 a. m. into right breast.

July 21. *U61* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U32, known to be infective. An equal amount of the same mixture was given at the same time to birds U64, U65, U66, and U67, as controls. All injections were made into left breast muscle about 3 p. m. Control bird U64 died, negative, July 26; U65 became + July 27 and died August 5 of severe malaria; U66 died, negative, July 27; U67 became + July 27 and had a mild infection.

July 28, 29, 30, and 31, and August 1. Daily blood smears from *U61* negative. (Each smear searched for 30 minutes).

July 30. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U61* injected into U69, which had negative blood smears July 31, and August 7, 8, 9, 11, 12, 14, 15, 16, 18, and 20. U69 became + August 27, which was six days after injection from U89, which was known to be infective.

August 2. *U61* died with no evidence of malaria.

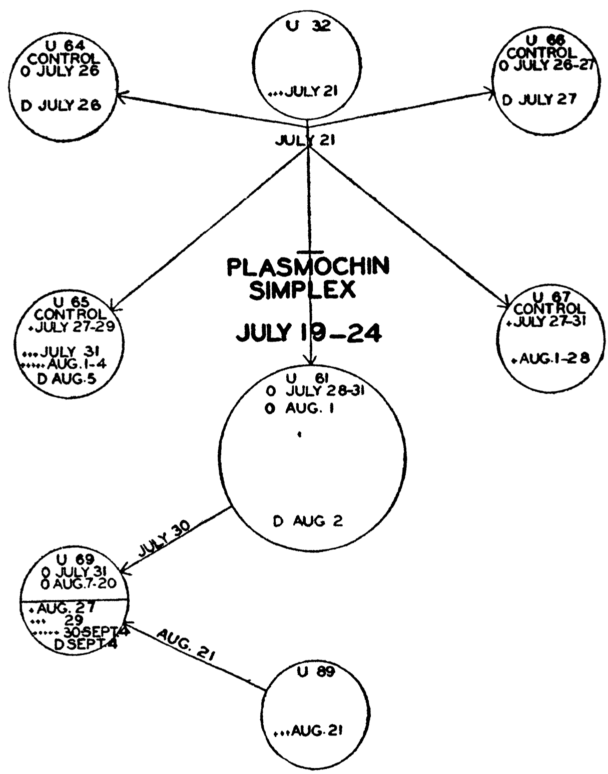

FIG. 11. Bird U61.

THIRD EXPERIMENT (AUGUST 9 TO OCTOBER 9, 1930)

Using a smaller dose, 0.00016 gram, as explained above, ten canaries, U78 to U87, were given daily intramuscular injections of plasmochin and were injected with infected blood on the third day (see fig. 11). Four controls, U88 to U91, were also injected with the same amount of the same blood taken at the same time. All of the controls developed typical malaria. Two of the birds receiving plasmochin, U82 and U83, died within ten days and were of no use in the experiment. The other eight all lived long enough to demonstrate clearly that their plasmochin injections had prevented malaria. Each of the four birds U78, U79, U80, and U84, after being negative for twenty-one days, was proved to be susceptible to the plasmodium used in the first injection. Four birds, U81, U85, U86, and U87, remained negative for forty-four days each and were then proved to be susceptible. Blood taken from U78, U79, U81, U85, and U87 on the twenty-first, sixteenth, fourteenth, and forty-fourth days, respectively, proved to be noninfective to birds that in each case after two weeks were proved to be susceptible birds.

There follow the protocols of birds U78, U79, U80, U81, U84, U85, U86, and U87. These are illustrated by figs. 12 to 19, inclusive.

THIRD EXPERIMENT

Protocol 1. Bird U78.

August 9, 1930. Blood smear from *U78* negative (30 minutes).

August 9 to 15. *U78* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U78* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16; U90 and U91, August 18. U91 died August 28 of severe malaria.

August 18, 19, 21, 23, 25, 27, and 29. Daily smears from *U78* negative. (Each smear searched for 30 minutes.)

September 1. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U78* injected into U97, which had negative blood smears September 1, 6, 9, 11, and 13. U97 became + September 22, which was seven days after injection from U80, which was known to be positive.

September 1. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U69, known to be infective, injected into *U78*.

September 6 and 8, *U78* +; September 9, 10, 11, 12, and 13, *U78* +++++; September 14, *U78* died of acute malaria.

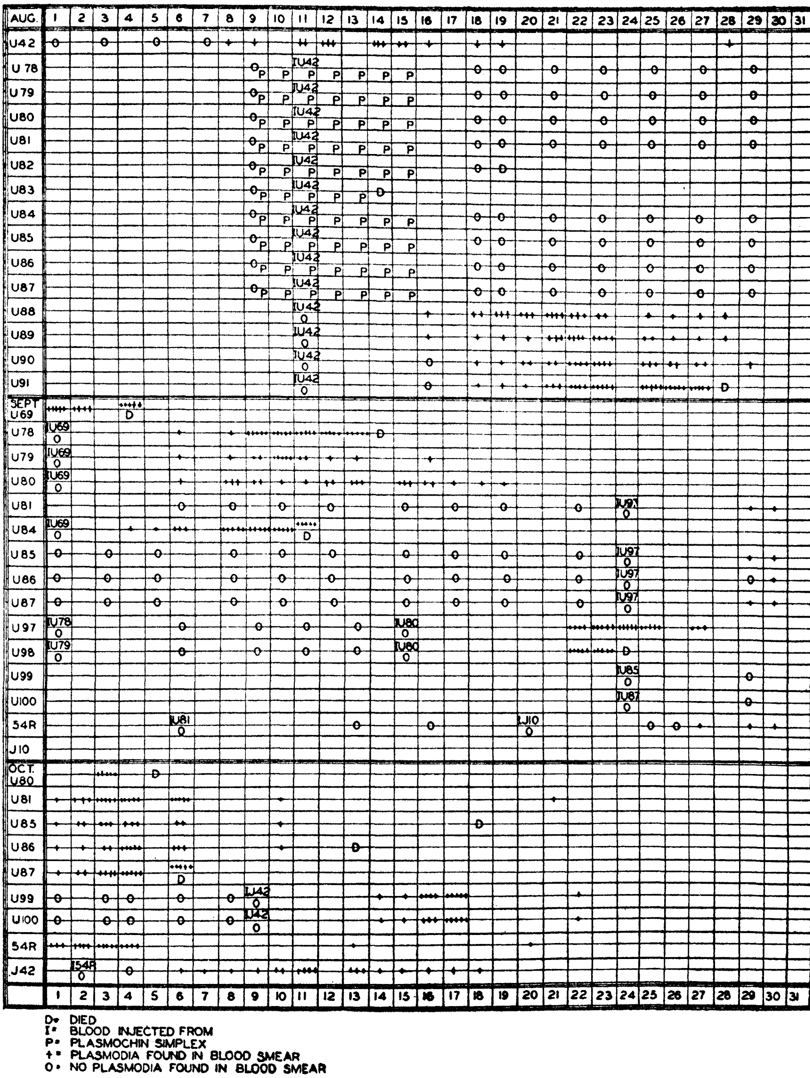

FIG. 12. Plasmochin simplex, a prophylactic drug in avian malaria. Third experiment.

Protocol 2. Bird U79.

August 9, 1930. Blood smear from *U79* negative (30 minutes).

August 9 to 15. *U79* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U79* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left

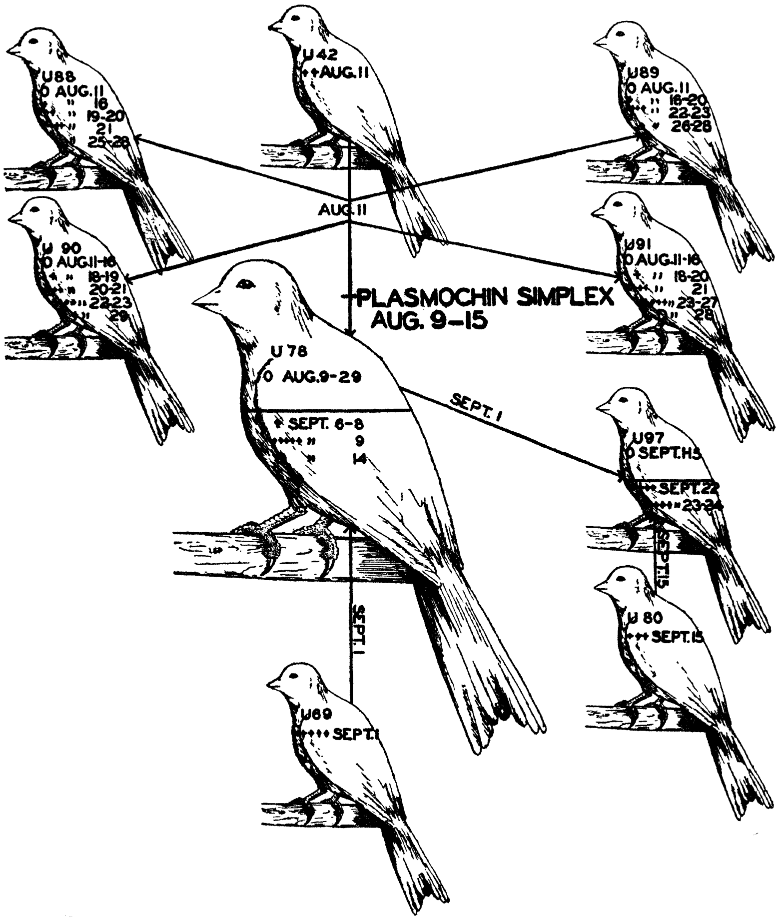

FIG. 13. U78.

breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

August 19, 21, 23, 25, 27, and 29, and September 1. Daily blood smears from *U79* negative. (Each smear searched for 30 minutes.)

September 1. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U79* injected into U98, which had negative blood smears September 1 to 15. U98 became positive September 22, which was seven days after injection from U80, which was known to be positive.

September 1. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U69, known to be infective, injected into *U79*.

September 6 to 8, *U79* +; September 9, *U79* ++; September 10, *U79* ++++; September 11, *U79* ++; September 12 to 16, *U79* +; October 3, *U79* died.

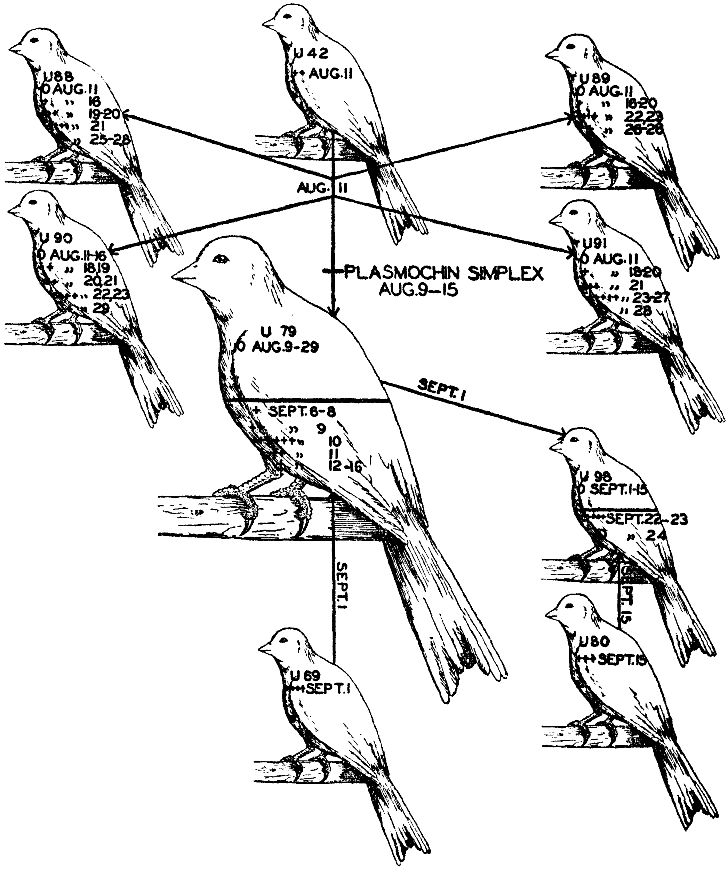

FIG. 14. Bird U79.

Protocol 3. Bird U80.

August 9, 1930. Blood smear from *U80* negative (30 minutes).

August 9 to 15. *U80* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U80* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

August 18, 19, 21, 23, 25, 27, and 29, and September 1. Daily blood smears from *U80* negative. (Each smear searched for 30 minutes.)

September 1. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U69, known to be infective, injected into *U80*.

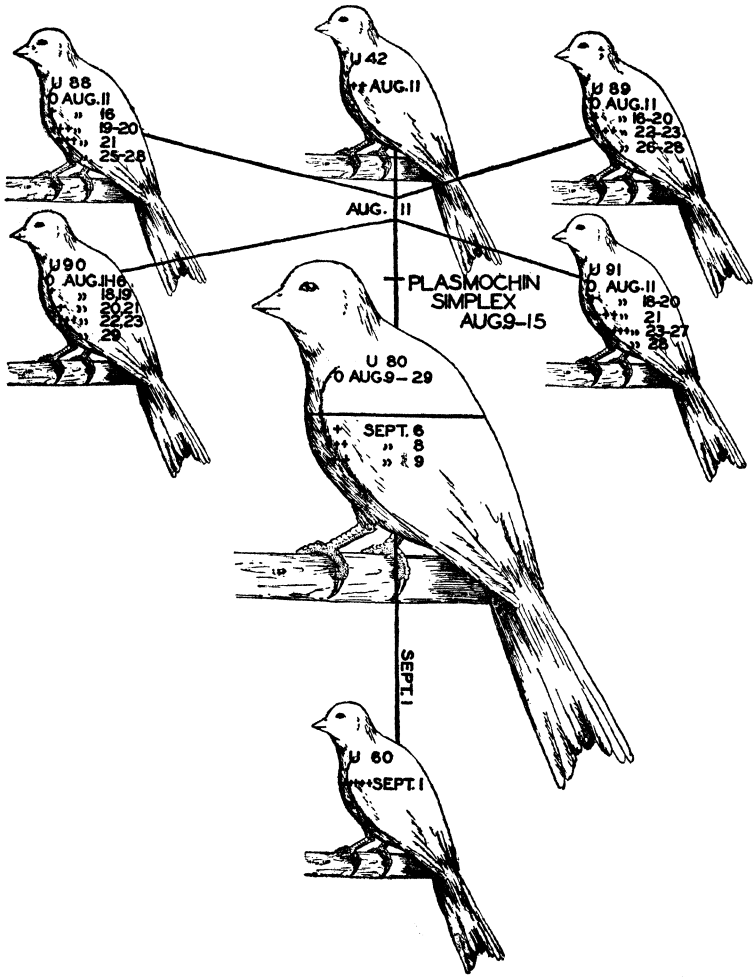

FIG. 15. Bird U80.

September 6, *U80* +; September 8, *U80* +++; September 9, *U80* ++; September 10 and 11, *U80* +; September 12, *U80* ++; September 13 and 15, *U80* +++; September 16, *U80* ++; September 17 to 19, *U80* +; October 3, *U80* +++++; October 5, *U80*, died.

Protocol 4. Bird U81.

August 9, 1930. Blood smear from *U81* negative (30 minutes).

August 9 to 15. *U81* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U81* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same

time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

August 18, 19, 21, 23, 25, 27, and 29, and September 6, 8, 10, 12, 15, 17, 19, 22, and 24. Daily blood smears from *U81* negative. (Each smear searched for 30 minutes.)

September 6. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U81* injected into 54R, which had negative blood smears September 6 to 26. 54R became positive September 27, which was seven days after injection from J10, which was known to be positive.

September 24. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U97, known to be infective, injected into *U81*.

September 29 and 30, *U81* +; October 1, *U81* +; October 2, *U81* +++; October 3 to 6, *U81* +++++; October 10 and 21, *U81* +.

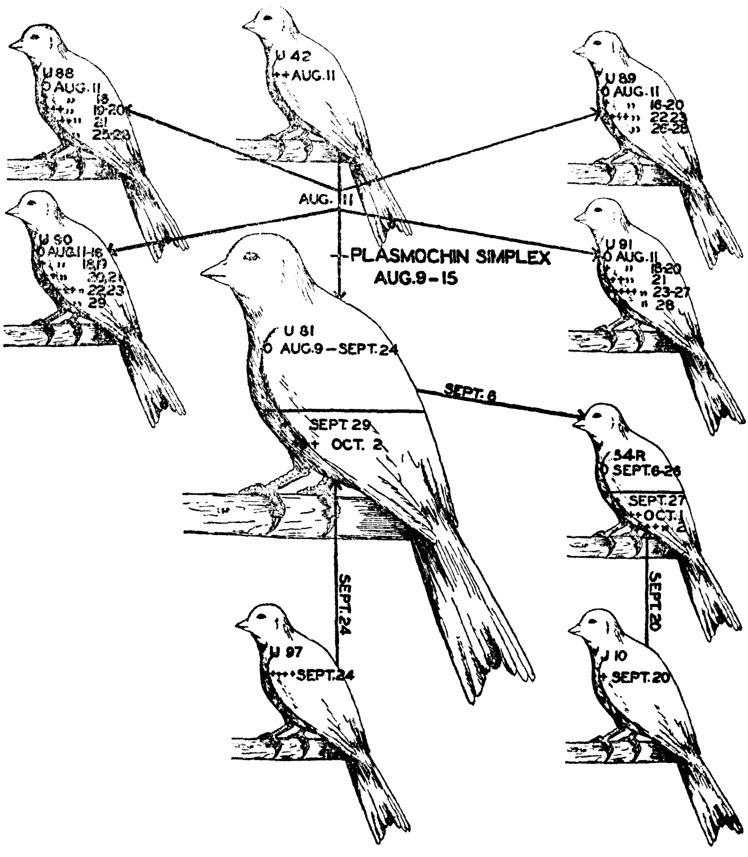

FIG. 16. Bird U81.

Protocol 5. Bird U84.

August 9, 1930. Blood smear from *U84* negative (30 minutes).

August 9 to 15. *U84* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U84* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

August 18, 19, 21, 23, 25, 27, and 29, and September 1. Daily blood smears from *U84* negative. (Each smear searched for 30 minutes.)

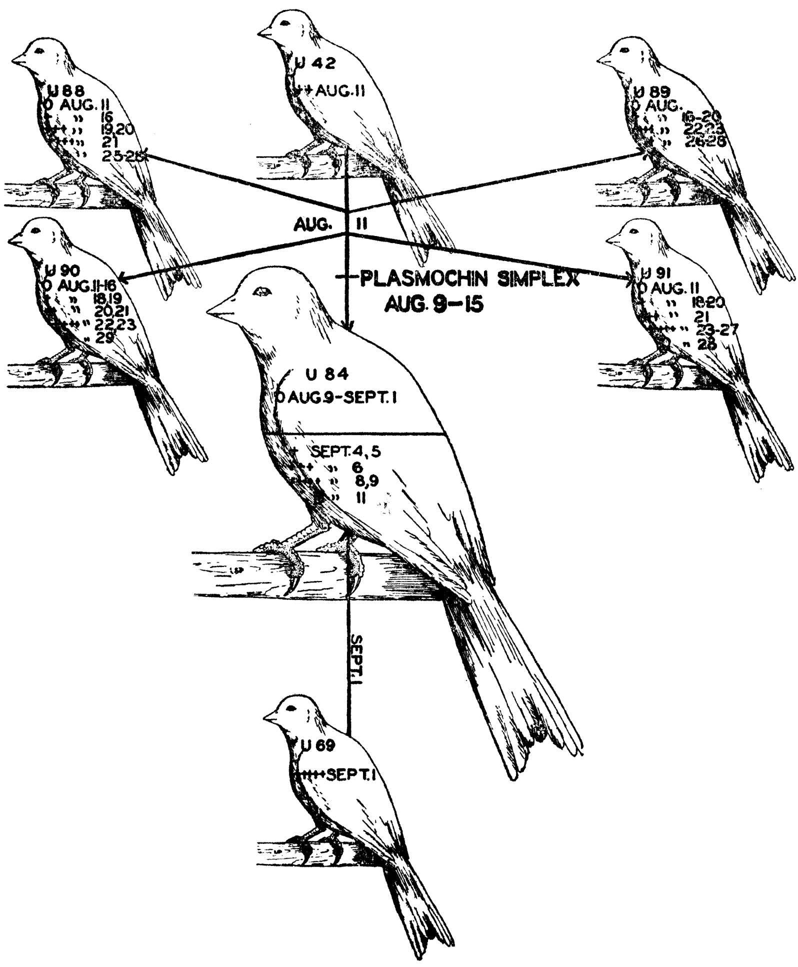

FIG. 17. Bird U84.

September 1. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U69, known to be infective, injected into *U84*.

September 4 and 5, *U84* +; September 6, *U84* +++; September 8 to 11, *U84* +++++; September 11, *U84* died.

Protocol 6. Bird U85.

August 9, 1930. Blood smear from *U85* negative (30 minutes).

August 9 to 15. *U85* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U85* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

August 18, 19, 21, 23, 25, 27, and 29, and September 1, 3, 5, 8, 10, 12, 15, 17, 19, 22, and 24. Daily blood smears from *U85* negative. (Each smear searched for 30 minutes.)

September 24. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U85* injected into U99, which had negative blood smears September 24 to October 19. U99 became positive October 14, which was five days after injection from J42, which was known to be positive.

September 24. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U97, known to be infective, injected into *U85*.

September 29 and 30 and October 1, *U85* +; October 2, *U85* ++; October 3 and 4, *U85* +++; October 6, *U85* ++; October 10, *U85* +; October 18, *U85* +++++; October 18, *U85* died.

Protocol 7. Bird U86.

August 9, 1930. Blood smear from *U86* negative (30 minutes).

August 9 to 15. *U86* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U86* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

August 18, 19, 21, 23, 25, 27, and 29, and September 1, 3, 5, 8, 10, 12, 15, 17, 19, 22, 24, and 29. Daily blood smears from *U86* negative. (Each smear searched for 30 minutes.)

September 24. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U97, known to be infective, injected into *U86*.

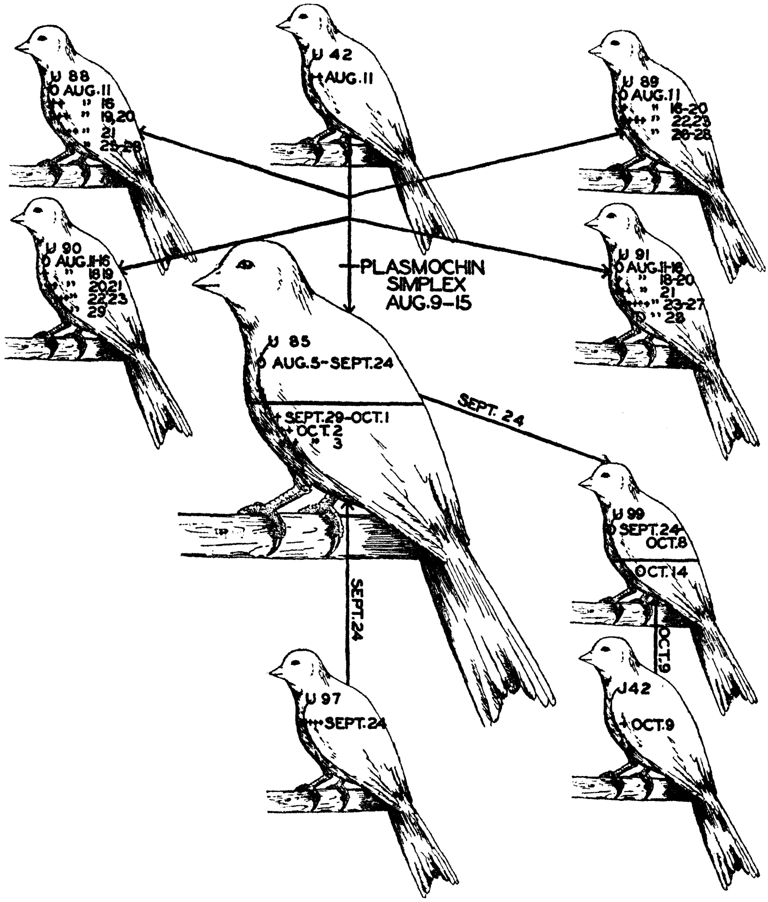

FIG. 18. Bird U85.

September 30 and October 1 and 2, *U86* +; October 3, *U86* ++; October 4, *U86* +++++; October 6, *U86* +++; October 10, *U86* +; October 13, *U86* died.

Protocol 8. Bird U87.

August 9, 1930. Blood smear from *U87* negative (30 minutes).

August 9 to 15. *U87* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 11. *U87* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U42, known to be infective. An equal amount of the same mixture was given at the same time to birds U88, U89, U90, and U91, as controls. All injections were made into left breast muscle. U88 and U89 became positive August 16. U90 and U91 became positive August 18. U91 died August 28 of severe malaria.

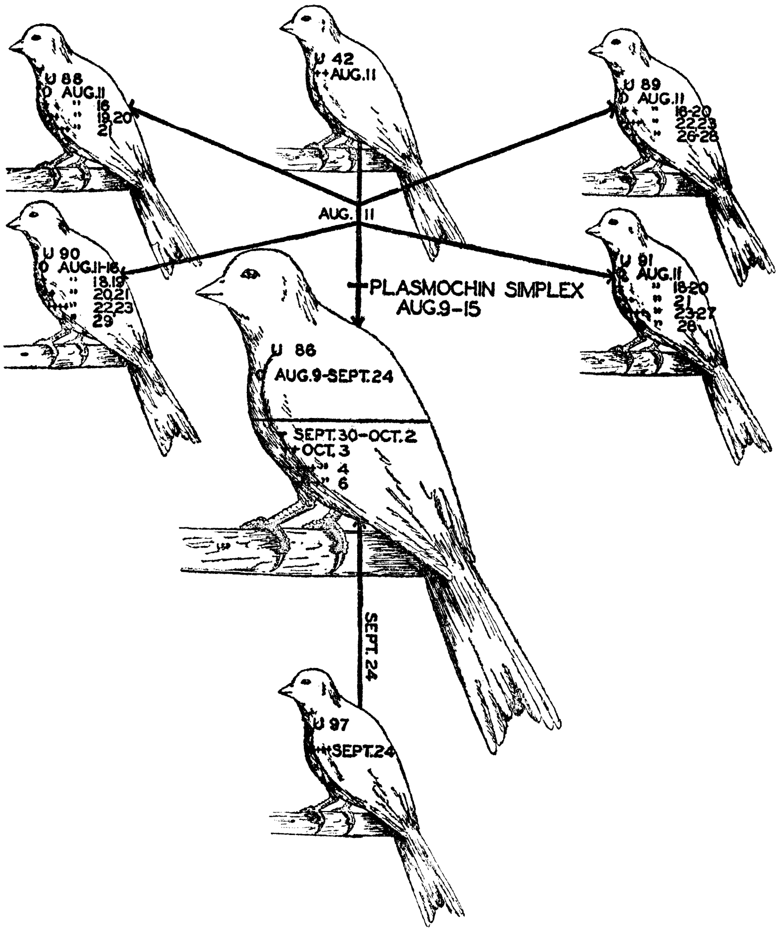

FIG. 19. Bird U86.

August 18, 19, 21, 23, 25, 27, and 29, and September 1, 3, 5, 8 10, 12, 15, 17, 19, 22, and 24. Daily blood smears from *U87* negative. (Each smear searched for 30 minutes.)

September 24. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *U87* injected into U100, which had negative blood smears September 24 to October 9. U100 became positive October 14, which was five days after injection from J42, which was known to be positive.

September 24. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U97, known to be infective, injected into *U87*.

September 29 to October 1, *U87* +; October 2, *U87* ++; October 3, *U87* ++++; October 4 and 6, *U87* +++++; October 6, *U87* died.

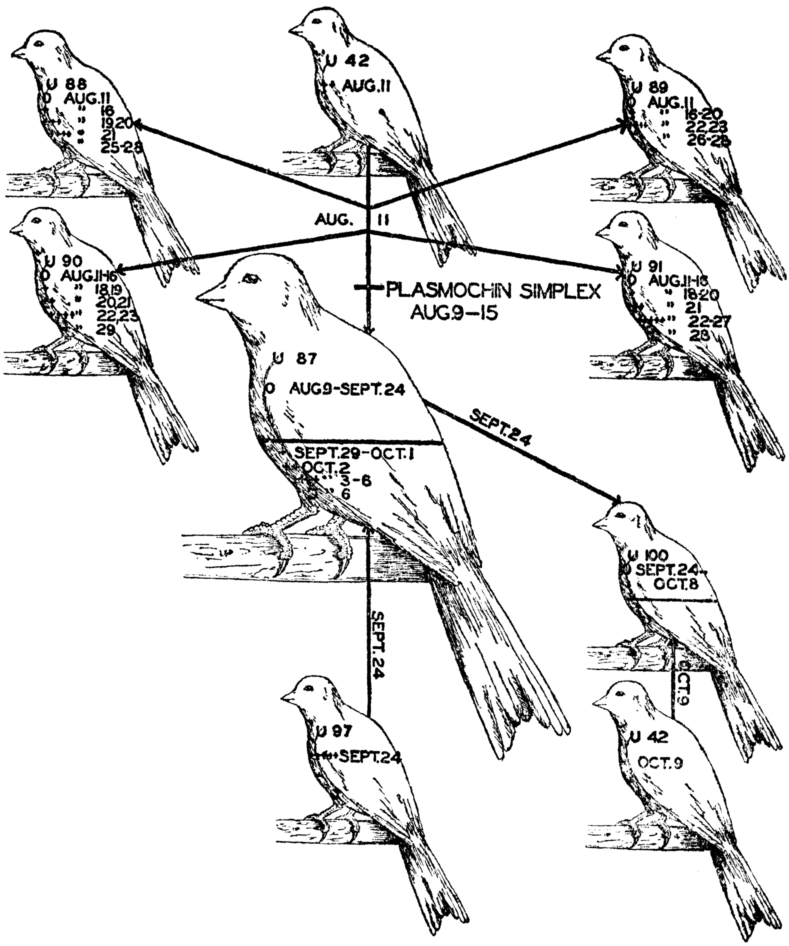

FIG. 20. Bird U87.

SUMMARY

Three experiments are reported in which canaries were given intramuscular injections of a mixture of saline and blood containing *Plasmodium cathemerium* on the third day of a week during which they received daily doses of plasmochin simplex intramuscularly. In no case was it possible to detect an infection in these birds, although in every case control birds that had not received plasmochin developed typical avian malaria.

CONCLUSION

It is concluded that the infection of a canary by experimental needle inoculation with *Plasmodium cathemerium* (Hartman,

1927) can be prevented by intramuscular injections of plasmochin simplex in daily doses of from 0.00016 to 0.0002 gram.

AUTHOR'S NOTE

These experiments were reported by the author in Bangkok in December, 1930, as noted on page 32, paragraph 77, of the 8th Congress—Far Eastern Association of Tropical Medicine—Abstracts of Papers and Programme of Scientific Sessions—Bangkok, December 9 to 12, 1930.

Because of the important implications of these experiments as regards human malaria they were also discussed and summarized in a paper published by the American Journal of Tropical Medicine in July, 1931.

That this emphasis was justified has been shown by the fact that, on June 6, 1931, it was reported in the London Lancet, volume 220, No. 5623, that James had protected not only birds but also humans against malaria by using beprochin, a drug probably identical with plasmochin. It would appear that once again an experiment in avian malaria has been a reliable indicator as regards human malaria.

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ILLUSTRATIONS

TEXT FIGURES

AVIAN MALARIA STUDIES, II

PROPHYLACTIC PLASMOCHIN VERSUS PROPHYLACTIC QUININE IN INOCULATED AVIAN MALARIA [1]

By Paul F. Russell

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SEVEN TEXT FIGURES

INTRODUCTION

In the first paper of this series(1) three experiments were reported in which experimental inoculation of canaries with *Plasmodium cathemerium* (Hartman, 1927) was invariably prevented by intramuscular injections of plasmochin simplex in daily doses of from 0.00016 to 0.0002 gram. In all cases the attempt to infect the birds was made on the third day of the series of plasmochin injections.

In the above-mentioned first paper a discussion was given of plasmochin and an extensive bibliography was prepared. There was also a full description of the technic of injection, of the examination of blood smears, and of other pertinent phases of the work.

The fourth experiment herein reported was along the same general lines but with the following two notable changes in procedure.

In the first place instead of attempting infection always on the third day, in this case inoculations were made on various days as noted below. Secondly, a parallel series of birds was studied in which prevention was attempted by using quinine instead of plasmochin.

In all other respects the technic followed was that described in the first paper.(1) The mortality among the birds used in this experiment is shown in Table 1.

[1] Misses Amparo Capistrano and Filomena Villacorta, microscopists on the staff of malaria investigations, assisted in the examination of blood smears in this experiment. The work was done at the Bureau of Science, Manila, with the coöperation of the International Health Division of the Rockefeller Foundation.

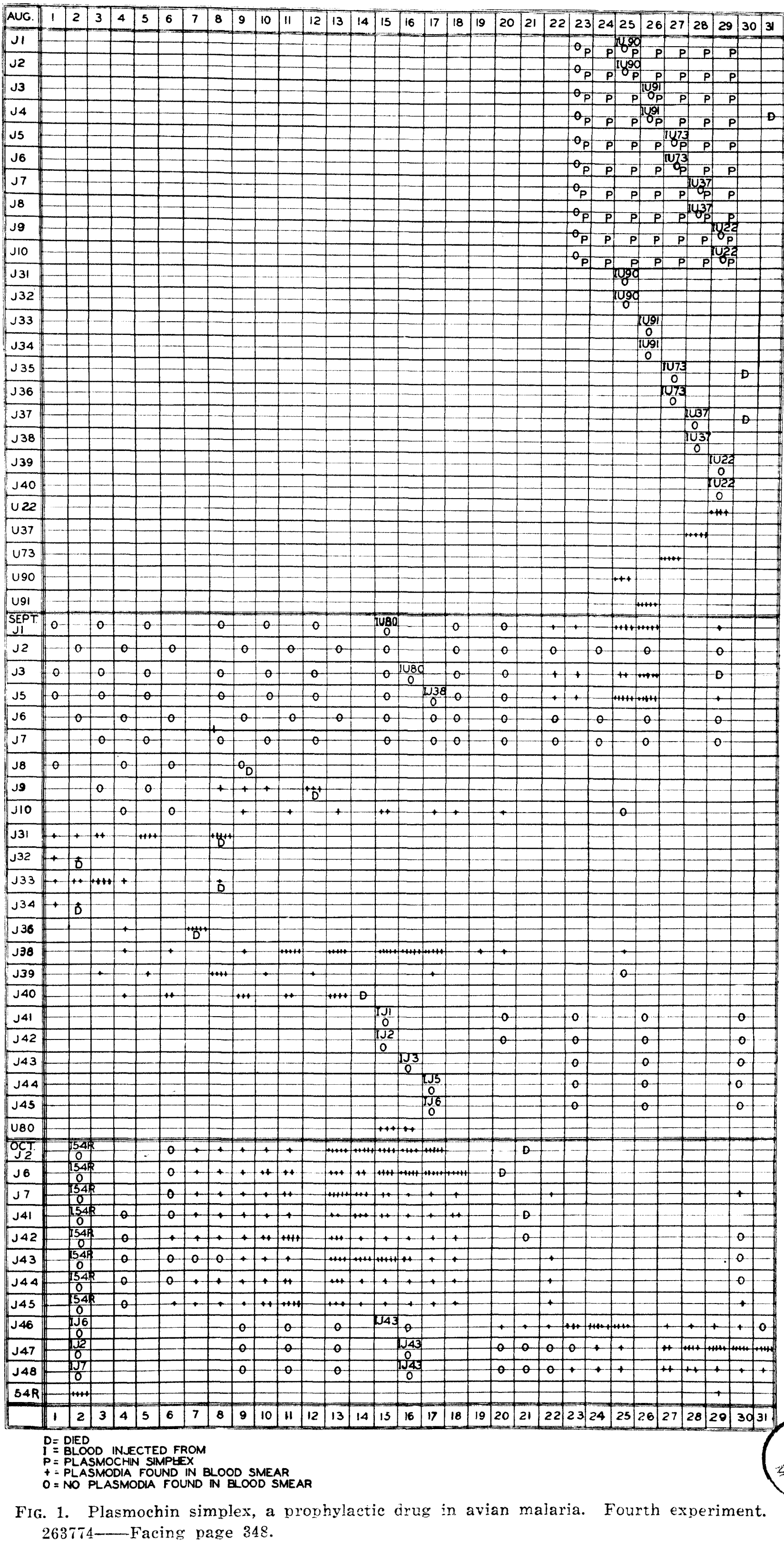
TABLE 1.—*Mortality of birds in fourth experiment.*

	Number of birds.	Died in 10 days or less.		Died in 15 days or less.		Died in 30 days or less.		Alive after 170 days.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Plasmochin series	10	1	10	1	10	3	30	4	40
Quinine series	20	1	5	6	30	11	55	6	30
Controls	10	4	40	5	50	8	80	2	20
Total	40	6	15	12	30	22	55	12	30

FOURTH EXPERIMENT—PLASMOCHIN SERIES (AUGUST 25 TO OCTOBER 20, 1930)

Ten canaries, J1 to J10, were each given an intramuscular injection of plasmochin simplex, 0.00016 gram, each morning for seven days at about 10 a. m. into the right breast muscle. Two birds, J1 and J2, were inoculated with infected blood into the left breast muscle at 3 p. m. of the third day. In a similar way J2 and J4 were inoculated on the fourth day; J5 and J6 on the fifth day; J7 and J8 on the sixth day; J9 and J10 on the seventh day (see fig. 1). The last pair, J9 and J10, therefore, received their inoculation of infected blood about five hours after the last injection of plasmochin. These two birds developed malaria on the tenth and eleventh days after inoculation and ran typical courses. The other eight birds, J1 to J8, all remained negative. Two control birds were injected each day with the same infected blood, in the same amount, and at the same time as the birds that had received plasmochin. These birds, J31 to J40, all became positive and had typical malaria, with the exception of J35 and J37, which died on the third and second days, respectively, after infection. (There remained at least one control bird for each day of infection.)

Of the birds receiving plasmochin, J4 and J8 died on the fifth and twelfth days, respectively, both negative. J1, J2, J3, J5, J6, and J7 remained negative for 26, 42, 25, 24, 40, and 39 days, respectively. Each was then proved to be a susceptible bird by an injection of positive blood. Each had a typical malaria course, J3 dying in the acute phase. Blood was taken from some of the plasmochin birds at intervals to test its infectiveness and invariably was noninfective, although in each case the recipient was subsequently proved to be susceptible. Table 2 lists these tests of infectivity.



D= DIED
I = BLOOD INJECTED FROM
P = PLASMOCHIN SIMPLEX
+ = PLASMODIA FOUND IN BLOOD SMEAR
O = NO PLASMODIA FOUND IN BLOOD SMEAR

FIG. 1. Plasmochin simplex, a prophylactic drug in avian malaria. Fourth experiment.
263774——Facing page 348.

TABLE 2.—*Tests of infectivity.*

Donor.	Days after attempted infection of donor.	Recipient.	Result.
J1	21	J41	Negative.
J2	21	J42	Do.
J2	38	J47	Do.
J3	21	J43	Do.
J5	21	J44	Do.
J6	21	J45	Do.
J6	36	J46	Do.
J7	35	J48	Do.

There follow the protocols of birds J1, J2, J3, J5, J6, J7, J8, J9, and J10. Text figs. 2 to 7 illustrate the protocols of birds J1, J2, J3, J5, J6, and J7.

FOURTH EXPERIMENT

Protocol 1. Bird J1.

August 23, 1930. Blood smear from *J1* negative (30 minutes).

August 23 to 29. *J1* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 25. *J1* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U90, known to be infective. An equal amount of the same mixture was given at the same time to birds J31 and J32, as controls. All injections were made into left breast muscle. J31 and J32 became positive September 1. J31 died September 8 of severe malaria.

August 25, and September 1, 3, 5, 8, 10, 12, 15, 18, and 20. Daily blood smears from *J1* negative. (Each smear searched for 30 minutes.)

September 15. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J1* injected into J41, which had negative blood smears September 15 to 26 and October 2 to 6. J41 became positive October 7, which was five days after injection from 54R, which was known to be positive.

September 15. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U80, known to be infective, injected into *J1*.

September 22 and 23, *J1* +; September 25, *J1* ++++; September 26, *J1* +++++; September 29 and October 3, *J1* +; October 20, *J1* 0.

Protocol 2. Bird J2.

August 23, 1930. Blood smear from *J2* negative (30 minutes).

August 23 to 29. *J2* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 25. *J2* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U90, known to be infective. An equal amount of the same mixture was given at the same time to birds J31 and J32, as controls. All injections were made into left breast muscle.

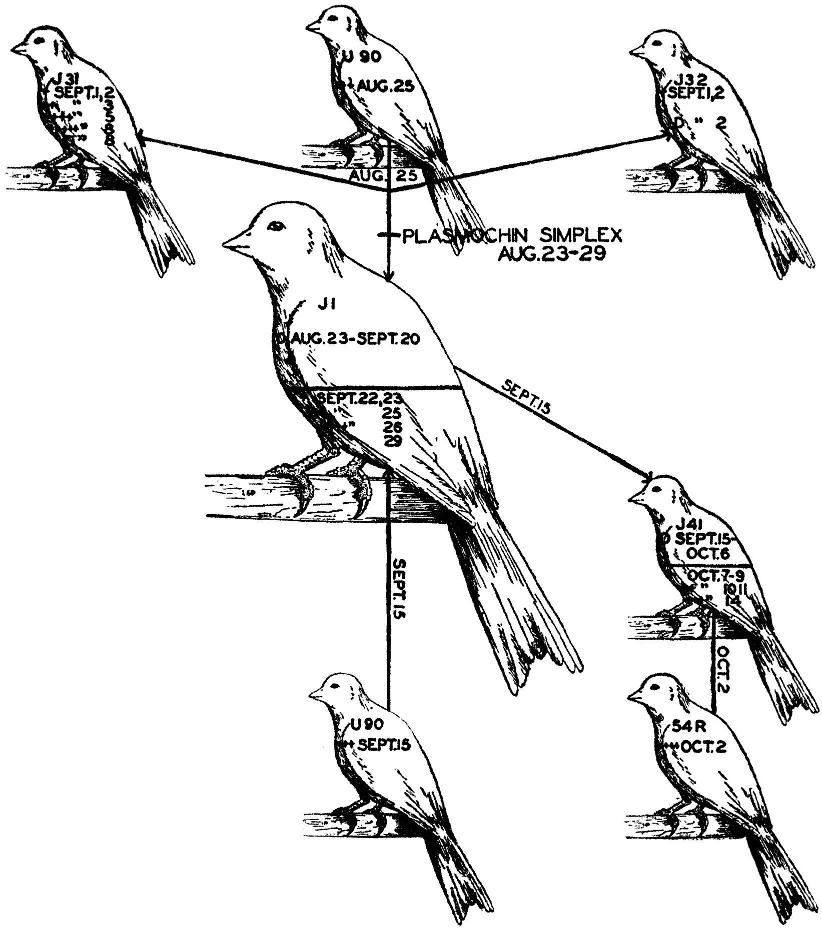


FIG. 2. Bird J1.

J31 and J32 became positive September 1. J31 died September 8 of severe malaria.

August 25, September 2, 4, 6, 9, 11, 13, 15, 18, 20, 22, 24, 26, 29, and October 2 and 6. Daily blood smears from *J2* negative. (Each smear searched for 30 minutes.)

September 15. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J2* injected into J42, which had negative blood smears September 15 to October 4. J42 became positive October 6, which was four days after injection from 54R, which was known to be positive.

October 2. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J2* injected into J47, which had negative blood smears October 2 to 23. J47 became positive October 24, which was eight days after injection from J43, which was known to be positive.

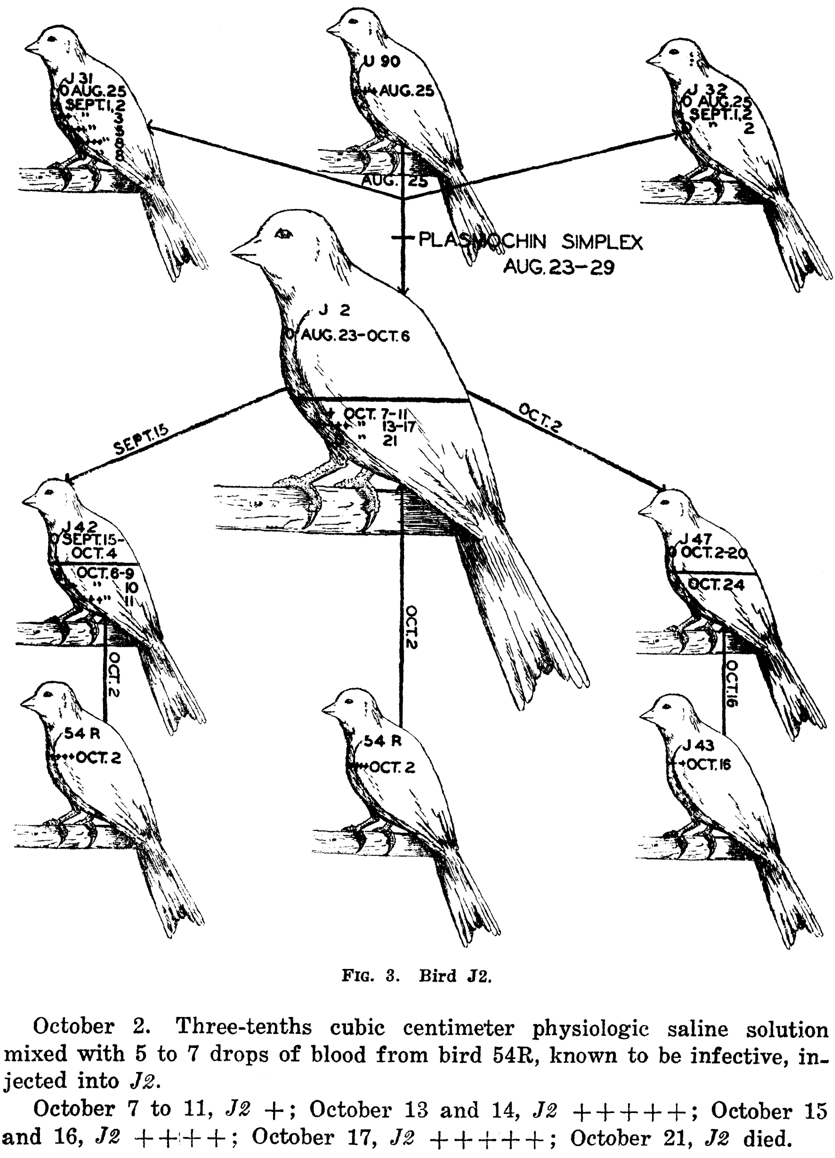


FIG. 3. Bird J2.

October 2. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird 54R, known to be infective, injected into *J2*.

October 7 to 11, *J2* +; October 13 and 14, *J2* +++++; October 15 and 16, *J2* ++++; October 17, *J2* +++++; October 21, *J2* died.

Protocol 3. Bird J3.

August 23, 1930. Blood smear from *J3* negative (30 minutes).

August 23 to 29. *J3* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 26. *J3* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U91, known to be infective. An equal amount of the same mixture was given at the same time to birds J33 and J34, as controls. All injections were made into left breast muscle.

J33 and J34 became positive September 1. J33 died September 8 of severe malaria.

August 26, and September 1, 3, 5, 8, 10, 12, 15, 16, 18, and 20. Daily blood smears from *J3* negative. (Each smear searched for 30 minutes.)

September 16. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J3* injected into J43, which had negative blood smears September 16 to October 8. J43 became positive October 9, which was seven days after injection from 54R, which was known to be positive.

September 16. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird U80, known to be infective, injected into *J3*.

September 22, 23, *J3* +; September 25, *J3* ++; September 26, *J3* + + + + +; September 29, *J3* died.

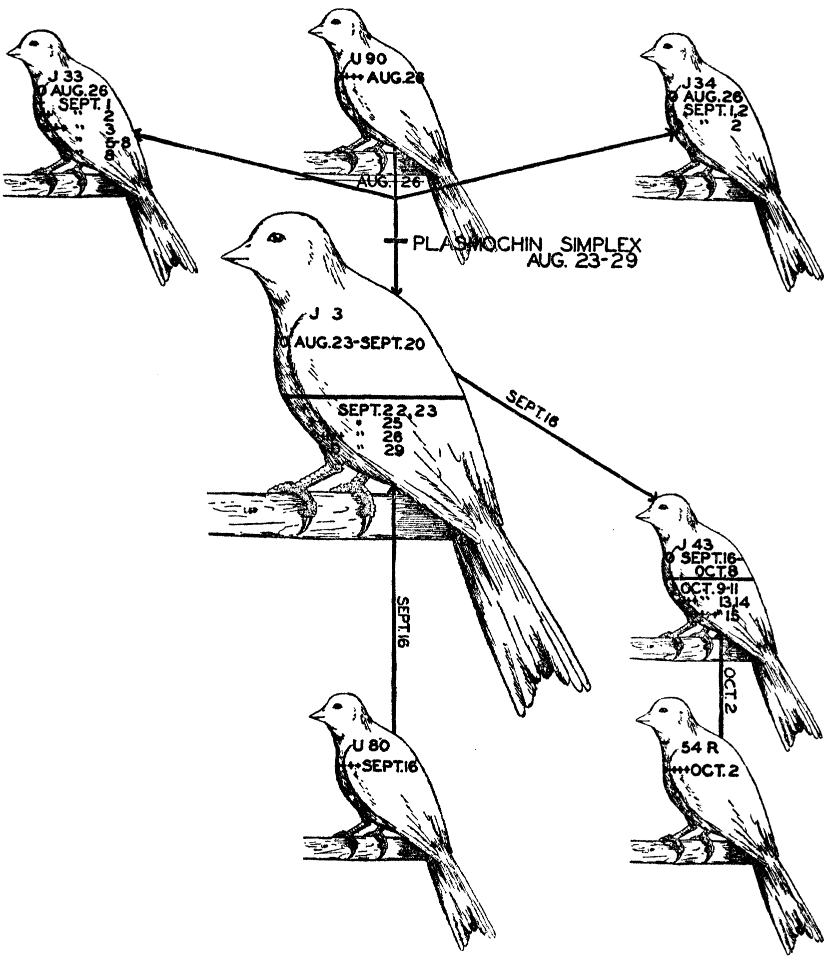


FIG. 4. Bird J3. Fourth experiment.

Protocol 4. Bird J5.

August 23, 1930. Blood smear from *J5* negative (30 minutes).

August 23 to 29. *J5* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 27. *J5* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U73, known to be infective. An equal amount of the same mixture was given at the same time to birds J35 and J36, as controls. All injections were made into left breast muscle. J36 became positive September 4 and died September 7 of severe malaria. (J35 died August 30, negative.)

August 27, and September 1, 3, 5, 8, 10, 12, 15, 17, 18, and 20. Daily blood smears from *J5* negative. (Each smear searched for 30 minutes).

September 17. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J5* injected into J44, which had negative blood smears September 17 to October 6. J44 became positive

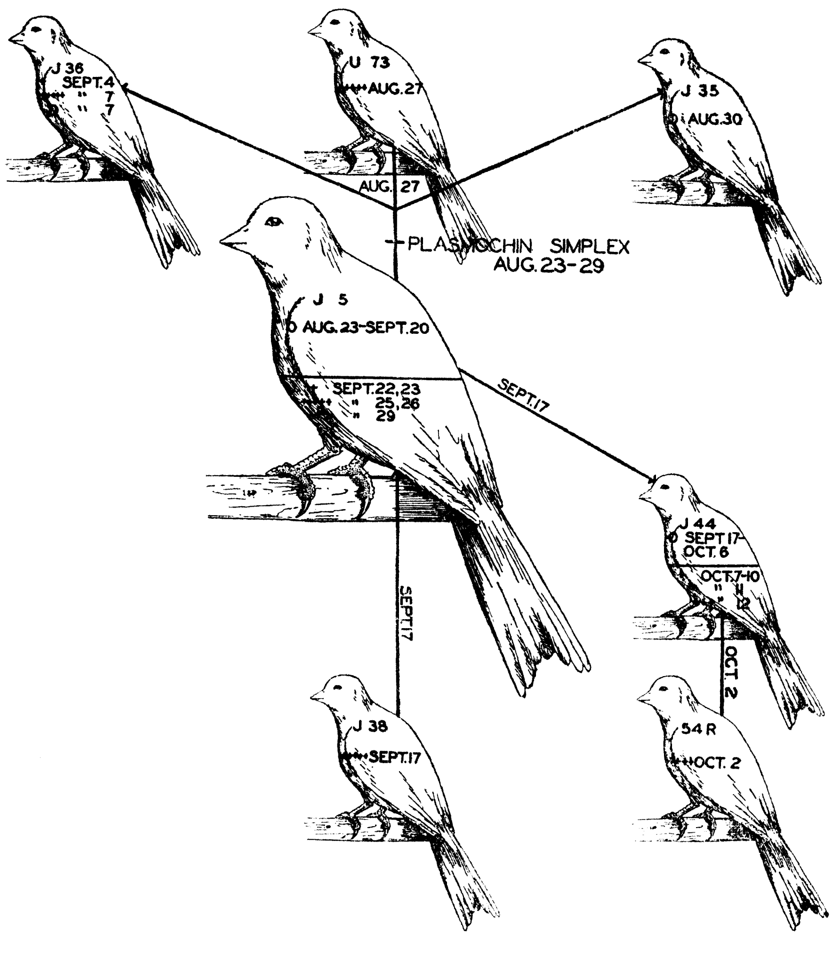


FIG. 5. Bird J5.

October 7, which was five days after injection from 54R, which was known to be positive.

September 17. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird J38, known to be infective, injected into *J5*.

September 22 and 23, *J5* +; September 25 and 26, *J5* +++++; September 29, *J5* +; October 3 and 20, *J5* 0.

Protocol 5. Bird J6.

August 23, 1930. Blood smear from *J6* negative (30 minutes).

August 23 to 29. *J6* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 27. *J6* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U73, known to be infective. An equal amount of the same mixture was given at the same time to birds J35 and J36, as controls. All injections were made into left breast muscle. J36 became positive September 4 and died September 7 of severe malaria. (J35 died August 30, negative.)

August 27, September 2, 4, 6, 9, 11, 13, 15, 17, 18, 20, 22, 24, 26, and 29, and October 2 and 6. Daily blood smears from *J6* negative. (Each smear searched for 30 minutes.)

September 17. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J6* injected into J45, which had negative blood smears September 17 to October 4. J45 became positive October 6, four days after injection from 54R, which was known to be positive.

October 2. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J6* injected into J46, which had negative blood smears October 2 to 16. J46 became positive October 20, which was five days after injection from J43, which was known to be positive.

October 2. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird 54R, known to be infective, injected into *J6*.

October 7 to 9, *J6* +; October 10 and 11, *J6* ++; October 13, *J6* +++; October 14, *J6* ++; October 15, *J6* ++++; October 16, 17, and 18, *J6* + + + + +; October 20, *J6* died.

Protocol 6. Bird J7.

August 23, 1930. Blood smear from *J7* negative (30 minutes).

August 23 to 29. *J7* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 28. *J7* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U37 known to be infective. An equal amount of the same mixture was given at the same time to birds J37 and J38 as controls. All injections were made into left breast muscle. J38 became positive September 4. (J37 died August 30.)

August 28, September 3, 5, 8, 10, 12, 15, 17, 18, 20, 22, 24, 26, 29, and October 2 and 6. Daily blood smears from *J7* negative. (Each smear searched for 30 minutes.)

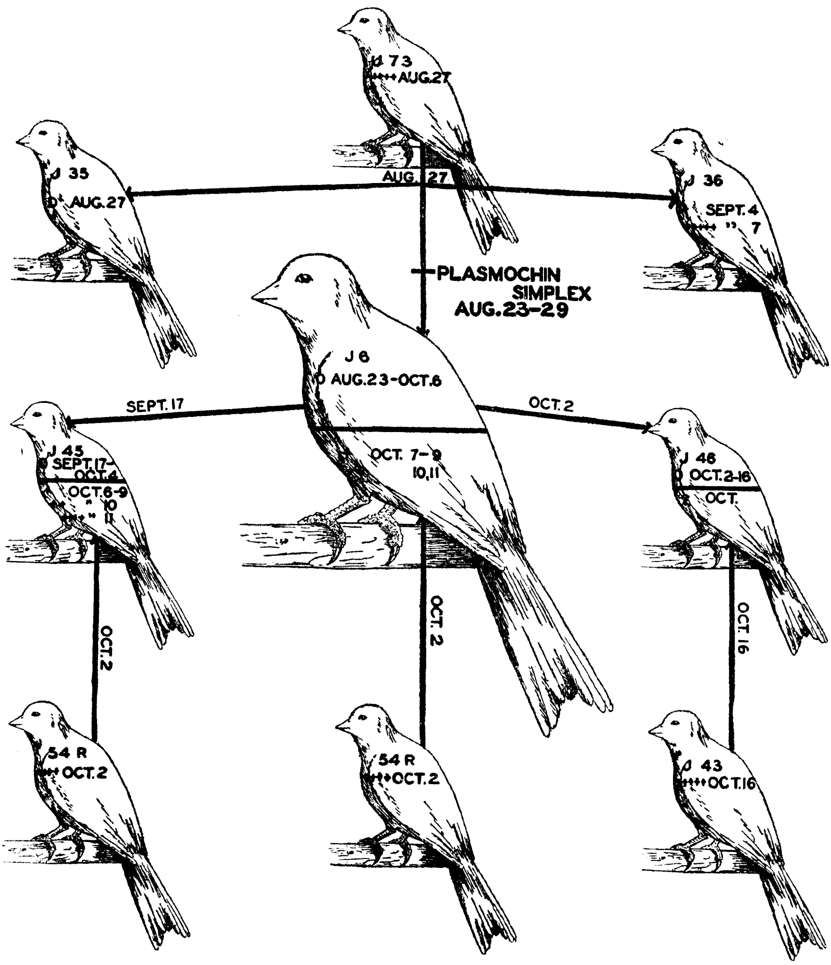


FIG. 6. Bird J6.

October 2. Three-tenths cubic centimeter of physiologic saline solution mixed with 5 to 7 drops of blood from *J7* injected into J48, which had negative blood smears October 2 to 22. J48 became positive October 23, which was seven days after injection from J43, which was known to be positive.

October 2. Three-tenths cubic centimeter physiologic saline solution mixed with 5 to 7 drops of blood from bird 54R, known to be infective, injected into *J7*.

October 7 to 10, *J7* +; October 11, *J7*, + +; October 13, *J7* + + + + +; October 14, *J7* +++; October 15, *J7* ++; October 16–22, *J7* +.

Protocol 7. Bird J8.

August 23, 1930. Blood smear from *J8* negative (30 minutes).

August 23 to 29. *J8* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

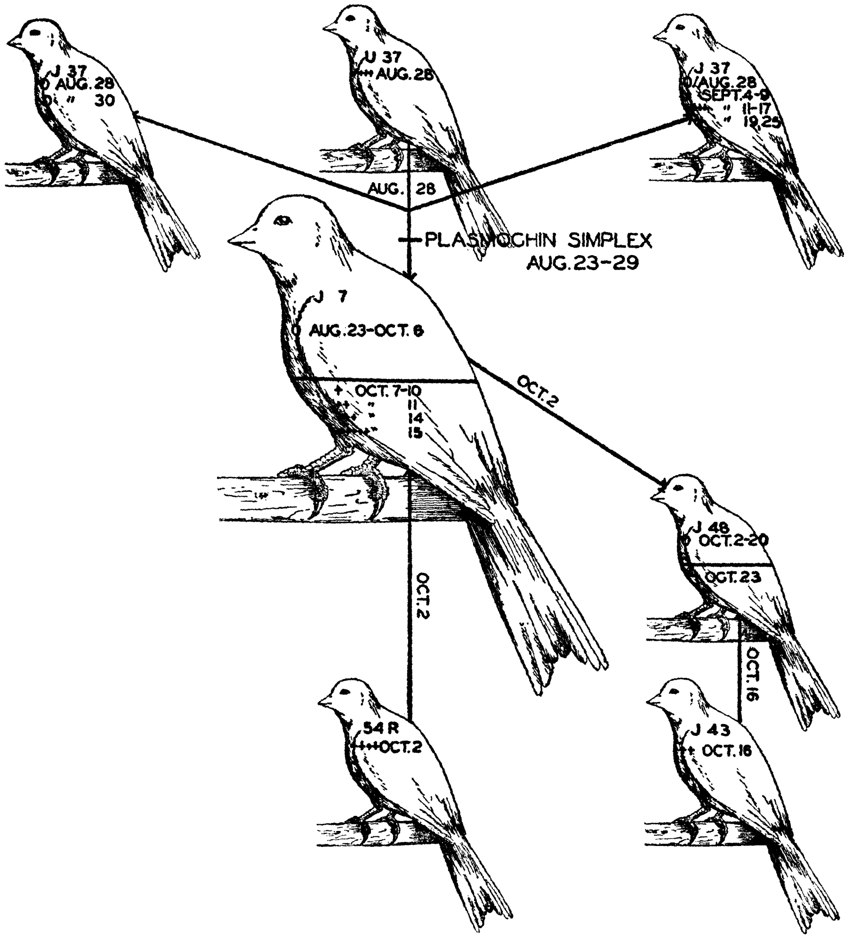


FIG. 7. Bird J7.

August 28. *J8* received 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U37, known to be infective. An equal amount of the same mixture was given at the same time to birds J37 and J38, as controls. All injections were made into left breast muscle. J38 became positive September 4. (J37 died August 30.)

August 28, September 1, 4, 6, 9. Daily blood smears from *J8* negative. (Each smear searched for 30 minutes.)

September 9. *J8* died.

Protocol 8. Bird J9.

August 23, 1930. Blood smear from *J9* negative (30 minutes).

August 23 to 29. *J9* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 29. *J9* received at 3 p. m. 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U22, known to be

infective. An equal amount of the same mixture was given at the same time to birds J39 and J40, as controls. All injections were made into left breast muscle. J39 became positive September 3. J40 became positive September 4.

August 29, September 3, 5. Daily blood smears from *J9* negative. (Each smear searched for 30 minutes.)

September 8 to 10. *J9* +; September 12, *J9* +++; September 12, *J9* died.

Protocol 9. Bird J10.

August 23, 1930. Blood smear from *J10* negative (30 minutes).

August 23 to 29. *J10* received 0.00016 gram plasmochin simplex by intramuscular injection about 10 a. m. each day into right breast.

August 29. *J10* received at 3 p. m. 0.3 cubic centimeter physiologic saline solution containing 5 to 7 drops of blood from bird U22, known to be infective. An equal amount of the same mixture was given at the same time to birds J39 and J40, as controls. All injections were made into left breast muscle. J39 became positive September 3. J40 became positive September 4.

August 29 and September 4 to 6. Daily blood smears from *J10* negative. (Each smear of blood searched for 30 minutes.)

September 9 to 13, *J10* +; September 15, *J10* ++; September 17 and 20, *J10* +; September 25, *J10* 0; October 20, *J10* +.

FOURTH EXPERIMENT—QUININE SERIES (AUGUST 25 TO OCTOBER 20, 1930)

DRUG

The drug used in these experiments was quinine dihydrochloride Lilly sold as a sterilized solution for intramuscular use. It was purchased at a local pharmacy in boxes of 12 ampoules of 1 cubic centimeter each. According to the label each ampoule contained 0.25 gram of quinine dihydrochloride in 1 cubic centimeter solution. This solution taken from the ampoules was diluted for this experiment with distilled water, and an attempt was made to determine a dose that would not produce marked symptoms of drug toxæmia in the birds.

Manwell(2) found the minimum lethal dose for quinine to be 0.006 gram for a bird of average weight and the minimum lethal dose of plasmochin to be 0.001 gram. His birds had an average weight of 16.5 grams. The birds used in the experiments reported in this and the first paper of the series averaged for 100 birds 15.98 grams in weight. Manwell(2) in his therapeutic studies used doses of 0.000132 gram of plasmochin dissolved in 0.1 gram of solution and 0.00075 gram of quinine (salt not specified) in 0.00075 gram of solution. This dose of quinine he subsequently increased to 0.001 gram in 0.1 gram of solution.

It should be noted that in Manwell's work the drugs were given orally by œsophageal tube, whereas in the experiments here reported the drugs—quinine dihydrochloride and plasmochin simplex—were given intramuscularly.

The dose of plasmochin as already discussed in the experiments here reported was 0.00016 to 0.0002 gram given in 0.1 cubic centimeter amounts.

The dose of quinine dihydrochloride finally determined as one which would not give symptoms was 0.0005 gram given in 0.05 cubic centimeter amounts. To each ampoule of the solution as purchased 24 cubic centimeters of distilled water were added and 0.05 cubic centimeter of the resulting solution constituted a dose. (Consult also Sergent.(4)) There was little or no necrosis of muscle at the site of injection. Care was taken to make deep injections well forward. The mortality in the 10-day period beginning with the first injection of quinine was 5 per cent in the birds receiving quinine and 40 per cent in the controls which received no drugs. (See Table 1.)

PROCEDURE

Twenty canaries, J11 to J30, were each given an intramuscular injection of quinine dihydrochloride, 0.0005 gram, each morning for seven days at about 10 a. m. into the right breast muscle. Four birds, J11, J12, J13, and J14, were inoculated with infected blood from bird U90 into the left breast muscle at 3 p. m. of the third day. In a similar way J15, J16, J17, and J18 were inoculated from bird U91 on the fourth day; J19, J20, J21, and J22 from bird U73 on the fifth day; J23, J24, J25, and J26 from bird U37 on the sixth day; and J27, J28, J29, and J30 from bird U22 on the seventh day. It will be noted by reference to the protocols of the plasmochin series in this paper that the same donor bird was used each day for the two birds being protected by plasmochin and the four in which an attempt was being made to protect by quinine.

The injections were all made with blood-saline mixture taken from the same vial and given in the same amount—0.3 cubic centimeter—as described in the first paper. The control birds on the third day were J31 and J32; on the fourth day J33 and J34; on the fifth day J35 and J36; on the sixth day J37 and J38; on the seventh day J39 and J40. These birds were also infected from the same corresponding vials using the same blood-saline mixture in the same amount given in the same way. The same

controls, therefore, served for both the quinine and the plasmochin series and these two series in turn acted as controls to each other.

RESULTS

It will not be necessary to give detailed protocols of each bird receiving quinine because, with the exception of birds J19 and J30, which died five days after inoculation, and controls J35 and J37, which also died soon after inoculation, all of the controls and all of the birds that had been given quinine as a preventive became infected. Quinine failed completely to prevent infection in every case. See Table 3 for detailed results of blood examinations in these birds and contrast them with the negative results in the plasmochin series in all but the two birds infected on the last day of their series of plasmochin injections.

TABLE 3.—*Quinine series.*

Number of bird.	Date inoculated, 1930.	Parasites first seen, 1930.	Number of days 4 or 5 plus.	Date of death.
J11	August 25	September 1	1	September 8, 1930.
J12	do	do	1	October 17, 1930.
J13	do	September 2	0	September 23, 1930.
J14	do	September 1	0	October 6, 1930.
J15	August 26	September 3	0	September 3, 1930.
J16	do	do	2	Alive February 18, 1931.
J17	do	September 2	4	September 15, 1930.
J18	do	do	2	Alive February 18, 1931.
J19	August 27			August 27, 1930.
J20	do	September 3	3	September 13, 1930.
J21	do	September 4	0	Alive February 18, 1931.
J22	do	do	3	September 12, 1930.
J23	August 28	September 5	0	September 6, 1930.
J24	do	do	0	Do.
J25	do	September 6	0	Do.
J26	do	September 4	1	Alive February 18, 1931.
J27	August 29	September 5	0	Do.
J28	do	do	0	Do.
J29	do	September 4	0	September 11, 1930.
J30	do			September 3, 1930.

The fact that the average prepatent period in the birds given quinine was 7.4 days and in the controls was 6.5 days is of doubtful significance because no attempt was made to adjust the quantity of the infective blood-saline inoculum to the size of the birds. The same dose of 0.3 cubic centimeter was given in every case as noted in the first paper of this series.(1)

Boyd(3) found that the prepatent period is a function of the size of the inoculum.

SUMMARY

Two experiments are reported in which attempts were made to prevent the infection of canaries following needle inoculations with *P. cathemerium* (Hartman, 1927). In the first experiment plasmochin simplex and in the second experiment quinine dihydrochloride was given in daily intramuscular doses for a week. Infection was attempted in some birds on the third day; in others on the fourth, or fifth, or sixth, or seventh day. The birds that had had plasmochin for seven days and were infected on the seventh day, five hours after their last dose of plasmochin, became infected, as did all of the birds receiving quinine. When infection was attempted on the third, fourth, fifth, and sixth days of the plasmochin series the attempt invariably failed.

CONCLUSION

1. It is concluded that the infection of a canary by experimental needle inoculation with *P. cathemerium* (Hartman, 1927) can be prevented by intramuscular injections of plasmochin simplex in daily doses of 0.00016 gram, provided that the bird receives at least one dose of plasmochin subsequent to receiving the infective inoculum.

2. It is concluded that the protective power of plasmochin in these needle inoculations is transitory and does not persist as long as five hours. (It may, therefore, be reasonable to conclude as a corollary that the protective power of plasmochin in experimentally inoculated malaria in birds is more therapeutic than preventive.)

3. Finally, it is concluded that quinine dihydrochloride in daily intramuscular doses of 0.0005 gram will not protect birds from experimental needle inoculations with *P. cathemerium* (Hartman, 1927).

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ILLUSTRATIONS

TEXT FIGURES

MALARIA TRANSMISSION IN THE PHILIPPINES, V

ON THE MATURATION OF THE OVA OF ANOPHELES FUNESTUS GILES [1]

By C. MANALANG

Of the Philippine Health Service, Manila

ONE TEXT FIGURE

In the 7th Congress, Far Eastern Association of Tropical Medicine, held at Calcutta (December, 1927), James, Nicol, and Shute [2] reported higher mortality of *Anopheles maculipennis* Mg. in some months than in others, as observed during a period of three and one-half years on forty-one batches of artificially infected mosquitoes in England. In June less than 2 per cent (should be less than 20 per cent or 17 per cent, an error in the decimal; see their table) survived to be infective, while in October at least 50 per cent would be available. By field observation they explained this to be due to the process of egg maturation and deposition, which caused high mortality. Their observations agreed with those of Swellengrebel in Holland [3] in regard to the period of egg maturation and oviposition of *maculipennis* (spring and summer) when no positive mosquitoes were found, and the autumn and winter months when the ova were not developed but with natural malaria infection in the mosquitoes. Their conclusions are:

> The lessons of these observations from the point of view of the spread of malaria seem to be (1) that in the future we must endeavor to correlate the seasonal incidence of primary malaria, not with the seasonal prevalence of mosquitoes concerned but with the seasonal prevalence of the individuals which live long enough to be transmitters. In June, there may be an enormous number of adult *maculipennis* in a malarious place but if we know that during that month less than 2% [should be less than 20 per cent] live long enough to become transmitters of the disease, their abundance is not so important. Obviously, it is much less important than a smaller abundance in August or September; the simple calculation from

[1] From the field laboratory, division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan.

[2] Trans. 7th Congress F. E. A. T. M. 2 (1927) 712–717.

[3] Malaria in the Kingdom of the Netherlands. Report to the malaria subcommittee of the Health Committee of the League of Nations (1927).

our figures that 100 mosquitoes in September are equal in importance to 3,000 in June [this should be 300, see their table] does not by any means express the true difference because the September mosquitoes will live several months while the June mosquitoes will live at the most only a few weeks; (2) If the process of egg maturation and oviposition is such an important cause of death that it almost entirely prevents the transmission of malaria by anopheles during the months of its occurrence, the number of broods that each species has in different localities and periods of the year during which maturation of eggs and oviposition occurs ought to be worked out much more carefully than has hitherto been attempted in many places. The results may provide a clue to the explanations of some observations on malarial incidence which are at present obscure.

Boyd,[4] using a standard measure of *A. quadrimaculatus* Say density (mosquitoes caught per man-hour search) noticed explosive increases in density, particularly those of the males, and concluded that in the latitude observed in southwestern Georgia this species may have from eight to ten annual generations, or a monthly generation, excepting in January and February. His records of dissection led him to conclude that "(a) The occasions when gland infections have been found have been preceded by the detection of stomach infections, and (b) Referring to the hypothetical brood curves, the stomach infections occurred at a period when the density of a generation has been at its maximum, while gland infections were found at the period when the brood was frankly in decline." As to ovarian development he found nulliparous females most abundant when the brood is on its upward phase and multiparous females encountered when the brood is on the wane. Boyd and Weathersbee,[5] observing along the coast of North Carolina (36° north latitude) found that in *quadrimaculatus* and *punctipennis* "gravid females were relatively high in number in the early winter and until oviposition began in January and February. Digestion of blood and development of the ovaries proceeds slowly thruout winter, the gravid females tending to withhold oviposition until the temperature is favorable."

Boyd[6] in a more recent article (p. 457) says:

No gravid females of *quadrimaculatus* were found during winter period. This shows that during the winter the distended abdomens of stage *e* females (Grassi and Sella) are to be attributed to an hypertrophied fat body. No instance of reproductive activity during the coldest winter month was

[4] Am. Journ. Hyg. 7 (1927) 264–275.

[5] Am. Journ. Hyg. 9 (1929) 682–694.

[6] Am. Journ. Hyg. 12 (1930) 449–466.

found. The statement in Boyd and Weathersbee (8) that "the majority of *A. quadrimaculatus* found in unoccupied places were gravid" is incorrect in the light of this information. It appears, therefore, that the imagines of *quadrimaculatus* encountered during the fall or winter periods are destined for, or are actually undergoing hibernation.

His table (p. 463) of seasonal distribution of infected specimens for 1926, 1927, and 1928 shows that the infections were found between June and October.

King's[7] twelve months' observation on natural malaria infection in the vicinity of Mound, Louisiana, records no infections in 1,375 *quadrimaculatus* caught in winter (November to April), but 12, or 1.96 per cent, of the 611 caught in summer (May to October) were infected.

The data for the present paper were collected from September, 1927, to August, 1929, in the La Mesa and South Portal camps of the Novaliches water project.

TABLE 1.—*Anopheles funestus caught in two years at La Mesa and South Portal giving percentages of insects with matured ova and the rates of infection.*[a]

Month.	Mosquitoes caught and dissected.			Stomach positive.		Salivary gland positive.	
	Total.	With mature ova.					
			Per cent.		*Per cent.*		*Per cent.*
January	932	51	5.4	11	1.2	8	0.8
February	327	25	7.6	6	1.8	3	0.9
March	878	55	6.2	15	1.7	14	1.6
April	668	115	17.2	4	0.6	9	1.3
May	686	71	10.3	18	2.6	19	2.8
June	782	103	13.1	8	1.0	11	1.4
July	883	98	11.1	23	2.6	10	1.1
August	571	116	20.3	17	3.0	7	1.2
September	1,058	48	4.5	8	0.7	8	0.7
October	1,190	105	8.8	12	1.0	2	0.1
November	767	33	4.4	8	1.0	4	0.5
December	803	47	5.8	14	1.7	9	1.1

[a] Matured ova in a positive mosquito were found in only one case (salivary gland) among almost 300 positives observed from six areas. Engorged stomach with oöcyst was not uncommon. In 15 cases both stomach and salivary glands were infected.

The table gives the monthly number of *A. funestus* Giles dissected, the number and percentage with ova (float and chitinous structures formed), and the stomach and gland infections. The

[7] Am. Journ. Hyg. 1 (1921) 35–39.

graph (fig. 1) shows a rise in mosquito infection coinciding with the months with the high rate of matured ova.

COMMENTS

The findings on *funestus* are, therefore, diametrically opposed to those of James in England and Swellengrebel in Holland that oviposition of *maculipennis* prevented malaria transmission due to shortening of its life.

The findings of *quadrimaculatus* by American investigators also do not agree with those of the Europeans.

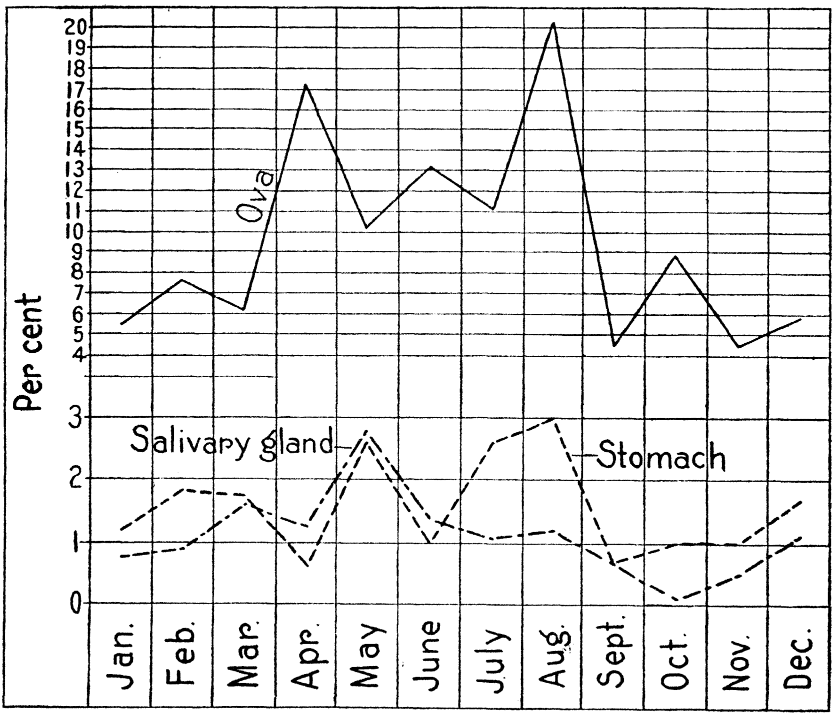

FIG. 1. Percentages of *Anopheles funestus* Giles with ova and with stomach and salivary-gland infections. La Mesa and South Portal camps, Novaliches water project, Luzon, September, 1927, to August, 1929.

The coincidence of higher malaria-infection rates in *funestus* with the higher rate of the females with matured ova indicates that this species not only survives oviposition but that the period with the maximum rate of matured ova is the period of maximum malaria transmission. This seems logical on biological grounds, and as indicated in my preceding article, the rates of infection in *funestus* rose with rainfall, temperature, and humidity. These meteorological factors undoubtedly ac-

celerate egg development and induce the mosquito to seek blood for the maturation of the eggs; consequently to bite man and become infected with gametes. When the ova mature and are deposited, more immature ova develop with a desire for human blood, so that with sporozoites in the salivary glands the mosquito bites man and infects him.

SUMMARY

1. Data on malaria infection and maturation of the ova of *Anopheles funestus* in La Mesa and South Portal camps of the Novaliches water project, Luzon, show higher rates of the former during the period of high rates of the latter, a finding opposite to those of James in England and Swellengrebel in Holland, who held that egg maturation and oviposition prevent malaria transmission due to the shortened life of *A. maculipennis*.

2. Findings on *A. quadrimaculatus* by American workers agree with the findings in the Philippines.

3. The findings on *A. funestus* seem logical on biological grounds.

ILLUSTRATION

TEXT FIG. 1. Percentages of *Anopheles funestus* Giles with ova and with stomach and salivary-gland infections. La Mesa and South Portal camps, Novaliches water project, Luzon, September, 1927, to August, 1929.

MALARIA TRANSMISSION IN THE PHILIPPINES, VI

THE DARK-NIGHT FACTOR [1]

By C. MANALANG

Of the Philippine Health Service, Manila

It is a general practice among anopheles-mosquito experimenters to cover the mosquito cage with black cloth if it is desired that the mosquitoes bite during the day or to expose the patient to them at night.

During December, 1927, and May and June, 1928, it was noticed on *Anopheles funestus* Giles dissection records from South Portal camp of the Novaliches water project, that malaria infection coincided with the new-moon period of the month, or a few days before or after the new moon.

To determine the relation between the positive catches and the moon periods, the calendar was divided into two periods of fifteen days each; namely, the full-moon period (seven days before and seven days after the full moon) and the new-moon period (seven days before and seven days after the new moon). In January, 1928, these two periods had an interval of one day, the fifteenth, while the new-moon period in the last half of the month overlapped one day with the full-moon period of February, on January 30; in March, the interval was on the fourteenth and the overlap on the twenty-ninth; in April, the interval was three days (the thirteenth, fourteenth, and fifteenth) and the overlap was two days, the twenty-ninth and thirtieth; in May, the overlap was on the twelfth; in June, the interval was on the twenty-sixth; in July, the overlap was on the tenth; in August, the overlap was on the eighth, with the interval on the twenty-third; in September, the overlap was on the seventh; in October the overlap was on the sixth; and in November, the overlap was on the fifth and the interval on the twenty-first.

[1] From the field laboratory, division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan.

The mosquito data in South Portal from December, 1927, to December, 1928, inclusive, are used in the present paper. These data contain the largest number of *funestus* infections registered in all the camps studied. Dissection findings were entered on the date of capture and not on the date of dissection. They were kept for several days after capture to allow positive blood meals to develop.[2] Positives falling on the overlapping dates were credited to the period before it. Two positives were thus credited to the new-moon period and three to the full-moon period. No positives were found in the intervening dates between the two periods except one on April 13, the eighth day after the full moon on April 5, which was credited to the full-moon period, there being an interval of three days.

Table 1 shows the distribution of positives in these periods and shows the influence of the darkness of the new-moon period on the number of infected *funestus*.

The darkness of the night was not recorded at the La Mesa camp, so it is not possible to correlate the mosquito findings during the dry months, December to April. The rain observation chart, however, indicated rain-gauge readings at 6 a. m. and 2 p. m. and noted the beginning and duration of the rain during the day or night. There was no record of the rainless but dark (cloudy) nights during the full-moon periods. Investigation of the rainy nights during the rainy months showed that thirty-two positives of the total seventy-two caught during the full-moon period, as shown in Table 1, were caught during twenty-one rainy nights from May 4 to November 27. Since these nights were usually dark, the relation of *funestus* infection and dark night is very clear.

Table 2 shows the number of infected *funestus* caught during dark and bright nights. Dark cloudy nights from December to April (dry season) and dark rainless nights during the full-moon period are not known.

By including the period, December, 1927, to April, 1928, when the darkness or brightness of the night was based only on the

[2] In an unsuccessful attempt to compare laboratory infectivity of different anopheline species, ten carriers were bitten by 1,157 mosquitoes with the following result: One *vagus* with two matured oöcysts died on the eighth day after the infective meal; one *funestus* with three matured cysts on the fourth day; one *karwari* with four matured oöcysts on the sixth day; and one *ludlowi* with twenty-two matured oöcysts on the seventh or ninth day after the infective meal.

new- and full-moon periods on the calendar, 80 per cent of the infected *funestus* were caught in the dark-night period. Excluding the December to April data (dry months), 87 per cent of the positives were caught during the known dark nights (with or without rain) and 13 per cent during the rainless nights, some of which, however, might have been bright or cloudy. Therefore, a susceptible has at least four times more chance of contracting malaria during the dark than during the bright nights, or 80 per cent of the infections are acquired during the dark nights. The moon has apparently no influence.

TABLE 1.—*Malaria in funestus distributed in the two moon periods.*

Month.	Number of positives.	
	New-moon period.	Full-moon period.
December, 1927	6	0
January, 1928	7	7
February	3	4
March	7	6
April	7	4
May	21	10
June	12	5
July	23	4
August	14	9
September	10	11
October	8	3
November	1	2
December	7	7
Total [a]	126	72
Per cent	63.6	36.4

[a] Positive stomachs, 113; positive salivary glands, 85.

COMMENTS

Table 3 shows the number of mosquitoes caught, the number of days employed in catching, and the average daily catch for the dark and bright nights (by calendar) and shows an average of twenty-three for the former and twenty for the latter. The twenty-one rainy nights of the full-moon periods from May to November gave a daily average of twenty-three *funestus*. So there was no increase in density during the dark nights, whether rainy or not. Larger numbers of them have been observed to enter the trap between 10 p. m. and 2 a. m. than at other times.

TABLE 2.—*Number of infected funestus caught during dark and bright nights.*[a]

Month	Number of positives.	
	Dark-night period.	Bright-night period.
December, 1927	6	0
January, 1928	7	7
February	3	4
March	7	6
April	7	4
May	24	7
June	16	1
July	23	4
August	23	0
September	19	2
October	11	0
November	3	0
December	9	5
Total	158	40
Per cent	80	20

[a] The number of cloudy or dark nights during full-moon periods of dry months, from December, 1927, to April, 1928, inclusive, is not known. The number of rainless but dark (cloudy) nights during the full-moon period is also not known.

Anopheles funestus, like the other anophelines, undoubtedly prefers to bite at night, as observed in experimental work. The camp people probably retire earlier during dark or rainy nights and give the mosquitoes an undisturbed chance to bite.

Culicines and some anophelines (*vagus* and *ludlowi*) are attracted by yellowish lantern light. At one of the Tungkong Manga laboratory traps, *A. philippinensis* came by the hundreds on two nights, attracted by the bright white light from an Aladdin lamp. *Funestus* were caught in South Portal traps with or without lantern light, so that it could not be said that a light in the trap guided them during dark nights. In the laboratory traps at Tungkong Manga, about 400 *funestus* were caught during the past ten months without using light.

The influence of bright or colored lights has not been tested. The study of illumination and transmission may give some clue to the factors causing prevalence of malaria in the rural, newly developed, out-of-the-way districts in the Philippines.

TABLE 3.—*Comparative density of mosquitoes between the two moon periods.*

Month.	New moon.			Full moon.		
	Number caught.	Number of days.	Daily average.	Number caught.	Number of days.	Daily average.
December, 1927	157	5	31	17	1	17
January, 1928	396	9	44	355	11	33
February	83	8	10	140	7	20
March	306	13	33	205	10	20
April	332	13	26	171	8	21
May	286	13	22	210	10	21
June	239	12	20	235	10	23
July	357	12	30	207	10	21
August	197	11	18	371	12	31
September	270	12	22	109	12	9
October	340	13	26	219	13	17
November	99	8	12	208	12	17
December	134	11	12	169	10	17
	--------	--------	--------	52	8	7
Total	3,196	140	--------	2,668	134	--------
Daily average	--------	--------	23	--------	--------	20

SUMMARY

1. Data collected during thirteen months of study of natural malaria infection of *A. funestus* in South Portal camp of the Novaliches water project show that at least 87 per cent of those infected were caught during the dark nights. Malaria transmission in the locality observed was at least four times more during the dark than during the bright nights, and the chance of contracting the disease was eighty times out of a hundred during the dark nights.

CAUSES OF IRRITATION UPON INJECTION OF IODIZED ETHYL ESTERS OF HYDNOCARPUS-GROUP OILS [1]

By HOWARD IRVING COLE

Chief Chemist, Culion Leper Colony, Philippine Health Service

At the recent conference of leprologists held under the auspices of the Leonard Wood Memorial for the Eradication of Leprosy, the majority of the delegates agreed that the ethyl esters of hydnocarpus-group oils are among the most active drugs at present available in the treatment of leprosy. Several leprologists stated that, by their methods of preparation, a nonirritating oil was essential for the production of esters of low-irritant quality. It is not always possible, however, for institutions situated many thousands of miles from the sources of supply to obtain oil that is fresh and nonirritating. It, therefore, becomes of prime importance that a method be devised by which even intensely irritating oils may be utilized for making relatively nonirritating ethyl esters. In order to accomplish this, it is necessary to take into consideration all the factors that may cause irritation and vary the method of preparation of the esters accordingly.

It has previously been found [2] that irritant properties of ethyl esters may be reduced by (1) elimination of free fatty acids; (2) elimination of decomposition products due to heating or chemical treatment; (3) elimination of volatile and nonvolatile impurities; and (4) addition of 0.5 per cent iodine.

Free fatty acids can be reduced to a minimum (less than 0.2 per cent) by careful neutralization with sodium hydroxide and very thorough washing. Free fatty acids are undoubtedly one of the main causes of irritation. To be certain that the amount present is less than 0.2 per cent, titration with tenth normal alkali should be made a part of the routine procedure for the preparation of the ethyl esters.

[1] Published with the approval of the Director of Health.

[2] Cole, Philip. Journ. Sci. 40 (1929) 503.

Decomposition products, formed upon heating or strong chemical treatment, and other volatile impurities can be largely blown out by steam.

If the esters are distilled, nonvolatile impurities and decomposition products remain in the still as residue. The distilled esters are decidedly more limpid than the undistilled, due probably to the fact that the latter contain some unchanged oil.

Addition of 0.5 per cent iodine markedly reduces the irritant effect of the ethyl esters providing that the method of iodization described below is strictly followed, in which case, the iodine is in the combined form. The presence of free iodine causes irritation.

The inherent irritant quality due to the configuration of the molecule of the compound is, of course, not removable without changing the compound itself. It has been shown that a synthetic compound similar to ethyl hydnocarpate, pure dinormal heptyl ethyl acetate,[3] is even more irritating than ethyl hydnocarpate, while the glyceryl ester of this synthetic compound (corresponding to a natural oil) is bland. This would indicate that part of the irritant effect of the ethyl esters is associated with the ethyl radicle.

A method of preparing hydnocarpus ethyl esters of a standard low-irritant quality, no matter how irritating the original oil may be, has already been described.[4] Since the publication of this process, however, continued experimentation has thrown further light upon the causes of irritation and their prevention.

RELATION BETWEEN IRRITATION AND TYPE AND SHAPE OF CONTAINER

Our standard method [5] for iodizing ethyl esters is as follows:

Fifteen liters of the purified esters are heated in a 20-liter enameled or stainless steel kettle to 140° C. The esters must be thoroughly dried before iodine is added since, if water is present, it effects by catalysis the hydrolysis of several per cent of the esters. If the filtered esters are clear, the heating to 140° C. before adding the iodine will drive off all dissolved water. Seventy-five grams of chemically pure resublimed iodine are added with stirring. The temperature immediately rises to 150° C., at which point it is maintained for exactly thirty minutes, the liquid being stirred occasionally. After cooling, the iodized esters are filtered into bottles (250 cubic centimeters capacity) and sterilized for one hour

[3] Private communication from C. B. Lara; drug prepared by Roger Adams.

[4] Cole, Philip. Journ. Sci. 40 (1929) 503.

[5] Loc. cit.

in an oven at 150° C. The temperature of the contents of the bottles reaches in this time 110° C.

Since this method of iodization was adopted, more than 3,000 liters of ethyl esters (200 lots of 15 liters each) have been iodized and used with practically no complaints of excessive irritation. Smaller institutions, however, might desire to make smaller lots of esters. It was found, in certain recent experimental work, that when the drug was iodized in 2-liter lots instead of the standard 15-liter batches, it was more irritating than usual, although the standard method was carefully followed, except for the fact that these lots were heated in tall, 3-liter glass beakers instead of low, stainless steel or enameled kettles. Experiments were then made using enameled beakers instead of glass beakers, but the drug so prepared was no less irritating. The form of the container was changed from a tall (beaker) type to a shallow (pan) type.[6] The preparations were equally irritating provided that the time of heating to 150° C. and time of cooling to room temperature of these two types were the same. In ordinary practice, however, with the low form (pan type), the drug heats more quickly and cools more rapidly than with the tall form. The longer time necessary to heat and cool the contents of the tall type of container corresponds to overheating of the drug, and we already know that overheating results in an irritant product. This rapid heating and cooling is evidently preferable, for the product in this case was less irritant and, in fact, entirely comparable with that produced by the standard method for 15-liter lots.

EFFECT OF STIRRING ON IODIZATION

In order to determine whether stirring during the iodization is beneficial or otherwise, two batches of esters were iodized at the same time under identical conditions, except that one lot was gently stirred only during the addition of the iodine, while the other one was vigorously stirred by means of a motor stirrer during the entire heating. The time of heating to 140° C. (15 minutes), the time of heating with iodine at 150° C. (30 minutes), and the time necessary to cool to 40° C. (2 hours) were kept constant for both lots by regulating the heat input. No

[6] It is assumed that the container will be more than half filled. The depth of the liquid would then be greater than the diameter in the tall type and should be not much more than half the diameter in the shallow type.

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TABLE 2.—*Effect of light, heat, and air on color and irritation of iodized ethyl esters.*

	Color in millimeters equivalent to 20 millimeters of standard.	
	Filled stoppered bottles.	Open beakers.
Before exposure	22	22
Exposed to direct sunlight, 10 hours	22	*35
Exposed to direct sunlight, 14 hours	22	*41
Exposed to direct sunlight, 14 hours plus 16 days in dark	22	*60
Exposed in dark, 10 days at 30° C	22	24
Exposed in dark, 14 hours at 50° C	22	28
Exposed in dark, 10 days at 50° C	22	*60

* Products marked thus were found to be very irritating upon injection.

Occasional stirring during iodization of the esters is probably beneficial. Continuous vigorous stirring is not necessary.

Experiments show that color comparison cannot be utilized as control in the production of standard relatively nonirritating iodized ethyl esters; time and temperature of heating of the esters with the iodine must be used as the basis of control.

Sunlight or heat in the presence of air soon changes the iodized esters in such a way as to yield an extremely irritating product. This deterioration is accompanied by increased clarity and change in color to reddish brown.

The author wishes to gratefully acknowledge his indebtedness to Dr. C. B. Lara and the medical staff at Culion for performing the irritation tests mentioned in this article.

DIE BRENTHIDEN DER PHILIPPINEN-INSELN

Von R. Kleine

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SECHSZEHN KARTEN

Der Catalogus Coleopterorum Junk-Schenklings, ed. 1, enthält nur 8 Arten von den Philippinen, davon sind 2 synonym so dass tatsächlich nur 6 Arten bekannt waren. Heute beträgt der Bestand 124 Arten.

In letzten Jahrzehnt sind umfangreiche Ausbeuten von den Inseln gekommen. Namentlich hat der leider viel zu früh verstorbene Charles Fuller Baker ein gewaltiges Material an Individuen zusammengebracht, das zum kleineren Teil von Prof. Heller, Dresden, später auf Hellers Empfehlung mir zur Bearbeitung überlassen worden ist. Im Zeitraum von mehreren Jahren habe ich zahlreiche Sendunge Bakers bearbeitet und einen guten Einblick in die Brenthidenfauna der Philippinen tun können. Dazu kommt noch ein Teil des Materials, das Boettcher, der, wie bekannt, für Moser gesammelt hat, mitgebracht hatte. Ferner sei noch auf das in der Sammlung des Bureau of Science zu Manila hingewiesen. Soviel darf ich wohl heute ohne Uebertreibung sagen: der wesentlichste Bestand der philippinischen Brenthiden-Arten ist heute bekannt. Was noch unbearbeitet in Museen liegt—es kann sich nur um das, früher in Mosers Besitz befindliche Material handeln—kann nicht mehr aufregen. Was wir von der Brenthidenfauna der philippinischen Inselwelt wissen wollen, wissen wir.

Die Arbeit soll einen rein zoogeographischen Charakter tragen.

Gelegentlich der Bearbeitung der philippinischen Lyciden[1] habe ich in der Einleitung zur Zoogeographie folgendes gesagt:

> Nach meinen Erfahrungen, die ich in jahrelanger Bearbeitung bei den Brenthiden gemacht habe, sind die Philippinen unbedingt zum austro-malayischen Gebiet zu rechnen. Der papuanische Einschlag, der sich namentlich in der Ausfärbung zeigt ist so bedeutend, dass man die Philippinen

[1] Philip. Journ. Sci. 31 (1926) 34.

als einen abgesprengten Teil Neu-Guineas ansehen könnte. Die Beziehungen zu den Molukken waren sehr gering, dagegen erwies sich als sicher, dass eine Zuwanderung aus dem orientalischen Gebiet stattgefunden hatte. Bei den Einwanderern handelte es sich um grosse, weitverbreitete Gattungen, die zum Teil auf den Philippinen mit ihrer Wanderung zu Ende gekommen waren und keinen Anschluss auf der südöstlichen Zugstrasse über Celebes gefunden hatten. Zum Teil sind es Arten, die im indo-malayischen Untergebiet weitverbreitet sind, also eine grosse Migrationsfähigkeit und -geschwindigkeit besitzen. Viele der Zuwanderer wurden auf Palawan festgestellt. Dass die Zuwanderung unbedingt über diese Inseln stattgefunden haben muss ist damit nicht gesagt, ich glaube vielmehr, dass der Zustrom im Zuge der Sulu-Inseln wenigstens ebensogross, wenn nicht noch grösser, gewesen ist. Leider sind diese zoogeographisch so wichtigen Inseln noch nicht exploriert.

Diese Ansicht halte ich auch heute noch aufrecht und schränke sie nur insoweit ein, als der Zustrom aus dem orientalischen Gebiet beiden Brenthiden grösser ist, als aus dem austro-malayishchen, eben, weil die Abtrennung von dem sich um Neu Guinea gruppierenden Landmassiv eine vollkommenere ist, als von den Sunda-Inseln. Wie in meiner Arbeit über die Lyciden, habe ich Palawan auch hier nicht zu den Philippinen gerechnet. Sie gehören organisch und faunistisch zu Borneo.

DIE VERBREITUNG AUF DEN EINZELNEN INSELN

Von Marinduque, Catanduanes, Burias, Tablas, Cebu, Ticao, Biliran und Dinagat lag mir kein Material vor. Die Werbreitung auf den einzelnen Inseln war folgende: Von den 124 Arten waren 6 ohne nähere Fundortangabe, 188 mit sicheren Fundorten belegten Arten fanden sich auf:

Luzon	58	Siargao	7
Polillo	4	Panay	3
Mindoro	2	Negros	26
Masbate	1	Mindanao	66
Samar	20	Basilan	15
Sibuyan	7	San Miguel	5
Leyte	9	Panaon	2
Bohol	1		

Die Gattungen sind, soweit sie mehrere Arten umfassen, auf den ganzen Archipel verbreitet. Die einzelnen Arten sind, wenigstens nach unseren bisherigen Kenntnissen, zum teil lokal. Bei häufigeren Arten kann man aber leicht feststellen, dass die einzelnen Inseln wahrscheinlich keine Endemismen beherrbergen, dass die Arten vielmehr auf allen Inseln zu finden sein werden. In nachstehender Tabelle ist die Verbreitung der einzelnen Arten angegeben.

	Prozent		Prozent
Endemisch	47.6	Java	28.2
Ceylon	8.1	Andamanen	9.0
Indien	16.2	Formosa	10.5
Bengalen	20.0	Japan	1.6
Indo-China	9.0	Celebes	9.0
Malay Halbinsel	31.4	Molukken	15.3
Sumatra	34.7	Neu-Guinea	7.4
Borneo	36.3	Australien	5.7

Danach zählen zum Indischen Untergebiet 53.3 prozent, zum Gebiet das sich um die grossen Sunda-Inseln und Malakka gruppiert 139.6 prozent, zum Palaearktikum 11.6 prozent und zum austro-malayischen und australischen Gebiet 37.4 prozent.

Vergleicht man die Zahlen in Bezug auf die mutmassliche Zuwanderung, so ist das Verhältnis wie 204.5 : 37.4 oder wie 5.5 : 1.

Am übersichtlichsten sind die Zahlen, wenn sie relativ angewandt werden, wie das vorstehend geschehen ist. Da fällt zunächst die hohe Zahl der Endemismen auf. Nicht weniger als 47.6 prozent kommen nur auf den Philippinen vor. Das ist fast die Hälfte aller Arten. Es muss angenommen werden, dass sich diese Zahl nicht wesentlich verändert, denn die Brenthidenfauna der orientalischen Region ist so weit bekannt, dass sich nicht viel mehr, wenigstens was die Zusammensetzung und Verteilung anlangt, verändern wird.

Wie steht es nun mit dem Vergleich zu anderen Faunengebieten? Ich will von einem Vergleich mit der aethiopischen, madegassischen und neotropischen Region absehen, da darüber bei Betrachtung der Tribus gesprochen wird. Es sollen hier nur Gebiete in Frage kommen, in denen philippinische Arten angetroffen worden sind. Ich fasse diese Gebiete in drei Gruppen zusammen: 1. Die eigentliche indische, westliche. Hierzu sind zu zählen: Ceylon, Indien, die um die Bucht von Bengalen liegenden Gebietsteile und Indo-China. Summiert man die relativen Zahlen so ergeben sich 53.3. Der indischen Gruppe möchte ich: 2. Ein zentrales Gebiet entgegenstellen, das die malayische Halbinsel, die Sunda-Inseln und die kleinen Inseln, die daran liegen, einbegreift. Die Addition der relativen Zahlenwerte gibt hier die Summe von 139.6. Als drittes kleines Gebiet soll Formosa und Japan gelten, die Gesamtsumme beträgt 11.6. Die östlich und südöstlich des zentralen Gebietes liegenden Molukken einschliesslich Celebes 24.3 und endlich Neu-Guinea mit Australien und den polynesischen Inseln 13.1.

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TABELLE 1.—*Tabelle der Verbreitung der philippinischen Brenthiden-Arten.*

Arten.	Luzon.	Polillo.	Mindoro.	Masbate.	Samar.	Sibuyan.	Leyte.	Bohol.	Panay.	Mindanao.	Basilan.	San Miguel.	Negros.	Siargao.
Calodromus crinitus Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Calodromus mellyi Guérin	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyphagogus buccatus Kleine	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Cyphagogus eichhorni Kirschbaum	—	—	—	—	—	+	—	—	+	+	—	—	+	—
Cyphagogus gladiator Kleine[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyphagogus humilis Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cyphagogus longulus Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cyphagogus modiglianii Senna [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyphagogus planifrons Kleine	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Cyphagogus silvanus Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cyphagogus simulator Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cyphagogus tabacicola Senna	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Cyphagogus westwoodi Parry	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Cyphagogus whitei Westwood [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Epigogus flexibilis Kleine	—	—	—	—	—	—	—	—	—	+	+	—	+	—
Orthopareia idonea Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Asaphepterum formosanum Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Opisthenoxys boetticheri Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Opisthenoxys ochraceus Kleine	—	—	—	—	—	—	—	—	—	+	+	—	+	—
Pseudocyphagogus squamifer Desbr.	—	—	—	—	+	—	—	—	—	—	—	—	+	—
Mesoderes fessus Kleine	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Atopomorphus schultzei Kleine	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Eterozemus laetus Senna	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Eterozemus pubens Senna	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Dictyotopterus philippinensis Kleine[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dictyotopterus pulcherrimus Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—

Jonthocerus asiaticus Kleine	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Jonthocerus bicolor Heller	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Jonthocerus laticostatis Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Jonthocerus modiglianii Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Stereodermus flavotibialis Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Cerobates adustus Senna	—	—	—	—	—	—	—	—	—	—	+	—	—	—
Cerobates aequalis Kleine	+	—	—	—	+	—	—	—	—	+	—	—	—	—
Cerobates angustipennis Senna	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Cerobates clinatus Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cerobates costatus Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cerobates formosanus von Schönfeldt	+	—	—	—	—	—	—	—	—	+	—	—	+	—
Cerobates grouvellei Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Cerobates sexsulcatus Motschulsky	+	—	—	+	—	—	—	—	—	+	+	—	—	—
Cerobates sumatranus Senna	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Cerobates tristriatus Fabricius	+	—	—	—	+	—	—	—	—	+	+	—	—	+
Homophylus mindanensis Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Metatrachelizus constans Kleine	—	—	—	—	—	—	—	—	—	—	—	—	—	+
Trachelizus bisulcatus Fabricius	+	—	—	—	+	—	+	—	—	+	+	—	—	—
Miolispa bicolor Kleine	+	—	+	—	+	—	—	—	—	+	—	—	—	—
Miolispa clavicornis Kleine	+	—	—	—	—	+	—	—	—	+	—	—	—	—
Miolispa cruciata Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa discors Senna	—	—	—	—	—	—	—	—	—	+	—	—	+	—
Miolispa elongata Kleine	+	—	—	—	—	—	—	—	—	+	+	—	+	—
Miolispa ephippium Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa flavolineata Kleine	+	—	—	—	—	—	—	—	—	+	+	—	—	—
Miolispa flexilis Kleine	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Miolispa formosa Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa fornicata Kleine	+	—	—	—	—	—	+	—	—	+	—	—	—	—
Miolispa fraudatrix Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa intermedia Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa lineata Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa pascoei Kleine	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa paucicostata Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—

[a] Von den mit *a* bezeichneten Arten sind keine näheren Fundorte bekannt geworden.

TABELLE 1.—*Tabelle der Verbreitung der philippinischen Brenthiden Arten*—Continued.

Arten.	Luzon.	Polillo.	Mindoro.	Masbate.	Samar.	Sibuyan.	Leyte.	Bohol.	Panay.	Mindanao.	Basilan.	San Miguel.	Negros.	Siargao.
Miolispa persersimilis Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa pulchella Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa robusta Kleine	+	+	+	—	+	—	—	—	—	+	+	+	—	+
Miolispa siporana Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Miolispa unicolor Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Hypomiolispa exarata Desbr.	—	—	—	—	+	—	—	—	—	+	+	—	—	—
Hypomiolispa helleri Kleine	—	—	—	—	—	—	—	—	—	+	+	—	—	—
Hypomiolispa nupta Senna	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Hypomiolispa ocularis Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Hypomiolispa sponsa Kleine	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Hypomiolispa tomentosa Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Hypomiolispa trachelizoides Senna	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Higonius cilo Lewis	+	—	—	+	—	—	—	—	—	—	—	—	—	—
Microtrachelizus fluxus Kleine	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Microtrachelizus pubescens Senna	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Microtrachelizus siamensis Kleine	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Microtrachelizus tabaci Senna	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Hoplopisthius trichimerus Senna	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Cordus peguanus Senna	—	—	—	—	—	—	—	—	—	—	+	—	+	—
Leptamorphocephalus fœderatus Kleine	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Paramorphocephalus setosus Kleine	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Agriorrhynchus ignarius Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Eupeithes dominator Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Prophthalmus longirostris Gyllenhal	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Prophthalmus tricolor Power	+	—	—	—	+	+	+	—	—	+	—	—	+	+
Baryrrhynchus schroederi Kleine	+	—	—	—	+	+	—	—	—	+	—	—	+	—

Eupsalis kleinei Heller	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Caenorychodes serrirostris Fabricius	+	—	—	—	+	—	+	—	—	+	+	—	—	+
Caenorychodes splendens Kirsch	+	—	—	—	—	+	—	—	—	—	—	—	+	—
Pseudorychodes praeclarus Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Amphicordus improportionalis Heller	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Ypselogonia peregrina Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Heteroblysmia accurata Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Heteroblysmia electa Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Heteroblysmia formidolosa Kleine	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Apocemus ignobilis Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Henarrhenodes macgregori Heller	+	+	—	—	—	—	—	—	—	+	—	—	+	+
Ectocemus badeni Kirsch	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Anepsiotes luzonicus Calabresi	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Anepsiotes nitidicollis Calabresi	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Achrionota bilineata Pascoe	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Achrionota spinifer Kleine	—	+	—	—	—	—	+	+	+	+	—	—	—	+
Cediocera tristis Senna	—	—	—	—	—	—	—	—	—	—	+	—	+	—
Heteroplites erythroderes Boheman	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Diurus furcillatus Gyllenhal	—	—	+	—	+	—	—	—	—	+	—	—	—	—
Diurus philippinicus Senna [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diurus samarensis Kleine	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Diurus shelfordi Senna	—	—	—	—	—	—	—	—	—	+	+	—	—	—
Opisthenoplus calabresii Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Opisthenoplus cavus F. Walker	+	—	—	—	—	—	—	—	—	+	—	—	+	—
Opisthenoplus fascinatus Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Opisthenoplus fecundus Kleine	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Opisthenoplus madens Lacordaire	—	—	—	—	—	+	—	—	—	—	—	—	—	—
Hormocerus reticulatus Fabricius	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Apterorrhinus compressitarsis Senna	+	—	—	—	—	—	+	—	—	—	—	—	—	+
Apterorrhinus albatus Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus angulaticeps Senna	+	—	—	—	—	—	+	—	—	—	+	+	+	—
Schizotrachelus bakeri Kleine	+	+	—	—	+	—	+	—	—	+	+	+	+	+

[a] Von den mit *a* bezeichneten Arten sind keine näheren Fundorte bekannt geworden.

TABELLE 1.—*Tabelle der Verbreitung der philippinischen Brenthiden-Arten*—Continued.

Arten.	Luzon.	Polillo.	Mindoro.	Masbate.	Samar.	Sibuyan.	Leyte.	Bohol.	Panay.	Mindanao.	Basilan.	San Miguel.	Negros.	Siargao.
Schizotrachelus brevicaudatus Lacordaire	+	—	—	—	—	+	—	—	—	—	—	—	+	—
Schizotrachelus brunneus Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus consimilis Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus corpulentus Kleine	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Schizotrachelus imbricellus Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus imitator Kleine	+	—	—	—	—	—	+	—	+	—	—	+	—	—
Schizotrachelus inconstans Kleine	+	—	—	—	—	—	—	—	—	—	—	—	—	—

TABELLE 2.—*Die philippinischen Brenthiden im Vergleich mit anderen Gebieten.*

	Endemismen.	Ceylon.	Indien.	Bengalen.	Indo-China.	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Andamanen.	Formosa.	Japan.	Celebes.	Molukken.	Neu-Guinea.	Australien.	Gesamtzahl der Arten.
Calodromini	10	2	10	11	1	14	13	13	11	3	1	—	—	3	—	1	26
Stereodermini	3	5	5	5	4	5	9	8	7	5	4	—	3	3	3	3	15
Trachelizini	19	1	2	6	1	11	9	13	9	—	5	2	3	4	2	1	36
Amorphocephalini	2	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	3
Arrhenodini	6	—	—	—	2	3	2	2	2	—	1	—	4	2	1	—	10
Belopherini	7	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	9
Ithystenini	4	—	—	—	—	—	3	4	2	—	—	—	—	3	1	—	8
Pseudoceocephalini	8	2	3	2	3	5	6	4	5	3	2	—	—	4	2	2	17
Total																	124

Ich habe in meinen zoogeographischen Studien mehrfach darauf hingewiesen, dass ich zwei Ausgangszentren annehme: das zentrale Afrika, aus welchem eine Wanderung nach Osten und Westen stattgefunden hat und ein grösseres, zusammenhängendes Landmassiv, dessen Reste in Neu-Guinea, Australien und dem gewaltigen Inselreich, das sich von Celebes bis Tahiti hinzieht hinzuzurechnen ist. Von hier aus hat eine zirkumpolare Ausbreitung stattgefunden. Auch nach Nordwesten sind die hier hergehörigen Formen gewandert, ohne indessen den aus Osten kommenden Zug der Familiengenossen Einhalt zu tun. Der aus Westen kommende Wanderzug hat sich als der stärkere erwiesen. Von den 124 auf den Philippinen gefundenen Arten gehören 107 dem westlichen (afrikanischen) Formenkreis an und 17 dem östlichen (austro-malayischen, bezw., australischen). Die Brenthiden-Fauna der Philippinen muss also als orientalisch angesehen werden.

Es wäre noch die Frage zu erörtern, ob sich auf den einzelnen Inseln ein besonderer Typ in der Ausfärbung ausgebildet hat. Es gibt Gebiete, zum Teil noch kleiner als die Philippinen, die einen bestimmten Farbentyp erkennen lassen und wo es leicht ist, die Zugehörigkeit der Art zum Gebiet festzustellen. Das kann man hier nicht sagen. Was die allgemeine Ausfärbung anlangt, so ist eine Tatsache allerdings sehr beachtenswert, nämlich, dass sich auf den Philippinen, und zwar nur dort, Farbenkomponenten zusammengefunden haben die sonst nur in Neu-Guinea und den angrenzenden Inseln zu finden sind: schwarze bis blauschwarze Grundfarbe und ziegelroter Prothorax. Es muss aber gleich darauf hingewiesen werden, dass nicht nur Arten südöstlicher Provenienz davon betroffen sind, sondern auch solche orientalischer Herkunft. Es kann also wohl mit Recht angenommen werden, dass die Inseln noch zum Landmassiv Neu-Guineas gehörte als die Hauptwanderung von Ost nach West und umgekehrt bereits beendet war.

Weiter sind die Deckenzeichnunger auf den Elytren insofern bemerkenswert, als sie die im vorigen Abschnitt geäusserte Ansich über die Zugehörigkeit zum alten Landmassiv Neu-Guineas dadurch unterstätzen, dass sich eine ganz ausgesprochen Längsstreifung bemerkbar macht. Die Orientalen haben eine entgegengesetzte Tendenz. Zu beachten ist die Tatsache, dass Palawan nicht zum Färbungsgebiet, wie überhapt nicht zu den Philippinen gehören, sondern zu Borneo. Eine genaue Durchforschung der Palawan-Inseln wäre von höchstem Interesse, um festzustellen, welche Bedeutung ihnen als Brücke zukommt.

SYSTEMATISCHER KATALOG DER PHILIPPINISCHEN BRENTHIDEN

CALODROMINI

Genus CALODROMUS Guérin

Calodromus GUÉRIN, Mag. Zool. (1832) t. 34.

CALODROMUS CRINITUS Kleine.

Calodromus crinitus KLEINE, Arch. Nat. A. 10 87 (1921) 24, fig. 1.

LUZON, Provinz Laguna, Mount Maquiling. (Belegstück im Museum zu Dresden.) Endemische Art.

CALODROMUS MELLYI Guérin.

Calodromus mellyi GUÉRIN, Mag. Zool. (1832) t. 34 ♂.

LUZON, Ilocos Norte, Bangui: Manila (Banks).

Die Art is häufig und weit verbreitet. In Indien ist *mellyi* häufig und in Bengalen nachgewiesen. Von Burmah bisher noch nicht bekannt, ist sie in Malakka, Sumatra und Borneo nicht selten. Von Java sah ich noch keine Belegstücke. *Calodromus mellyi* soll auch auf Ceylon gefunden sein, ich konnte die Behauptung nicht entkräften, sah aber das Tier noch nicht von dort.

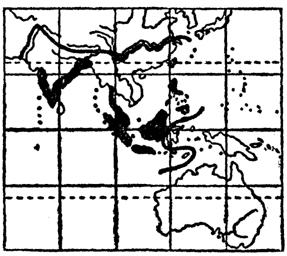

FIG. 1. Verbreitungskarte der Gattung *Calodromus* Guér.

Die Gattung ist orientalisch. Verwandte Formen finden sich in Sumatra in der Gattung *Allaeodromus* Senna und der aethiopischen Gattung *Cormopus* Kolbe. Die Gattungen sind durch die überbildeten Tarsen in eine Verwandtschaft zu bringen. In die austro-malayische Region ist *Calodromus* nicht vorgedrungen. Habituell besteht innerhalb der Gattung grosse Einformigkeit.

Genus CYPHAGOGUS Parry

Cyphagogus PARRY, Trans. Ent. Soc. London 5 (1849) 182.

CYPHAGOGUS BUCCATUS Kleine.

Cyphagogus buccatus KLEINE, Ent. Mitt. 1–4 (1916) 9, figs. 6, 7.

MINDANAO, Provinz Lanao, Kolambugan (*Boettcher*). SAMAR (*Baker*).

Sicher kommt die Art auch auf anderen Inseln vor, denn sie ist häufig und weit verbreitet. Ausserdem ist sie leicht erkennbar. In dem mir vorgelegenen Material konnte ich sie nachweisen von: Ceylon, Indien, Andamanen, Malakka, Sumatra, Borneo, und Java. Das Verbreitungsgebiet ist geschlossen, da *buccatus* auch von Bengalen nachgewiesen ist.

CYPHAGOGUS EICHHORNI Kirschbaum.

Cyphagogus eichhorni KIRSCHBAUM, Mitt. Zool. Mus. Dresden 1 (1875) 45.

MINDANAO, Provinz Lanao, Kolambugan (*Baker*); Provinz Davao, Davao (*C. M. Weber*). NEGROS, Cuernos Mountains (*Baker*). SIBUYAN (*Baker*). N.–W.–PANAY (*Baker*).

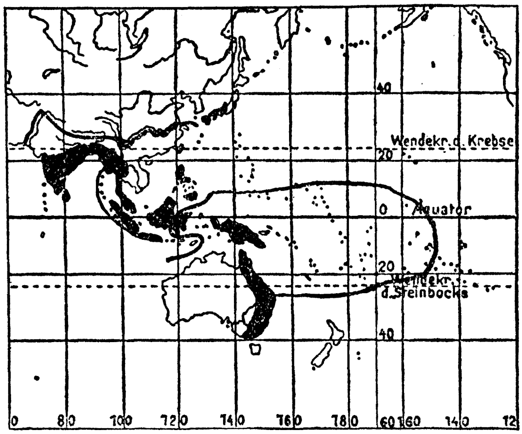

FIG. 2. Verbreitungskarte der Gattung *Cyphagogus* Parry.

Wie *buccatus* ist auch *eichhorni* verbreitet und leicht erkennbar. Nach Westen wird Burmah nicht überschritten, in Indien fehlt sie. Auf der Malayischen Halbinsel häufig, ist sie von Mentawei und Borneo nachgewiesen. Sehr wahrscheinlich lebt sie auch auf Sumatra, von Java sicher nicht bekannt. *Cyphagogus eichhorni* ist ferner auf die Molukken übergegangen, wie ich selbst feststellen konnte.

CYPHAGOGUS GLADIATOR Kleine.

Cyphagogus gladiator KLEINE, Arch. Nat. A 6 87 (1921) 307, figs. 3, 13.

Ich sah die Art von den Philippinen nicht gerade selten, nähere Fundorte kann ich aber nicht angeben. Die allgemeine Verbreitung ist der der beiden vorhergehenden Arten ähnlich: Assam, Malayische Halbinsel, Mentawei, Sumatra und Borneo.

CYPHAGOGUS HUMILIS Kleine.

Cyphagogus humilis KLEINE, Philip. Journ. Sci. 28 (1925) 590.

MINDANAO, Provinz Lanao, Kolambugan (*Banks*). Endemische Art.

CYPHAGOGUS LONGULUS Senna.

Cyphagogus longulus SENNA, Not. Leyd. Mus. 2 (1898) 52.

MINDANAO, Provinz Agusan, Cabadbaran (*C. M. Weber*).

Verbreitung: Siam, Malayische Halbinsel, Java, Ceram, Batjan. Sehr wahrscheinlich ist die Art auch auf Sumatra und Borneo zu Hause, ich sah aber noch keine Belegstücke von dort.

Der Uebergang von den grossen Sunda-Inseln nach den Philippinen ist ohne Berührung von Sumatra und Borneo nich recht denkbar. Die Verbreitung dürfte der von *buccatus* und *eichhorni* analog sein.

CYPHAGOGUS MODIGLIANII Senna.

Cyphagogus modiglianii SENNA, Ann. Mus. Genova (2) 13 (33) (1893) 258.

Ohne näheren Fundort aus Sammlung Baker.

Eine weit verbreitete, aber zerstreut vorkommende und seltene Art, deren ganzes Verbreitungsgebiet sicher noch nicht bekannt ist. Senna beschrieb die Art von Sumatra, Insel Engaño. Ich sah Stücke von Pahang, der Fundort überrascht nicht. Der Fund von den Philippinen schliesst sich zwanglos an. Etwas ungereimt erscheint dagagen das Vorkommen in Nord-Queensland. Es liegt allerdings kein Ausnahmefall vor. Man kann gleichweite Verbreitung mehrfach feststellen, es handelt sich dann allerdings um häufige Arten mit grosser Migration.

CYPHAGOGUS PLANIFRONS Kirschbaum.

Cyphagogus planifrons KIRSCHBAUM, Mitt. Zool. Mus. Dresden 1 (1875) 46.

MINDANAO, Provinz Lanao, Iligan (*Baker*). SAMAR (*Baker*).

Häufige Art in der weiten Verbreitung von *buccatus* und *eichhorni:* Indien, Assam, Malayische Halbinsel, Borneo, Sumatra, Java. Das Verbreitungsgebiet ist also gut abgeschlossen.

CYPHAGOGUS SILVANUS Senna.

Cyphagogus silvanus SENNA, Boll. Soc. Ent. Ital. 35 (1902) 154.

Bisher lag mir nur einmal ein Stück aus der Boettcher'schen Ausbeute mit unleserlichem Fundort von Mindanao vor. Allgemeine Verbreitung gleich der vorigen Art: Indien nicht selten, Malakka, Sumatra, Mentawei, Borneo, Java, Buru.

CYPHAGOGUS SIMULATOR Senna.

Cyphagogus simulator SENNA, Boll. Soc. Ent. Ital. 34 (1902) 155.

MINDANAO (*Baker*). Näherer Fundort fehlt.

In der Verbreitung sehr wahrscheinlich mit *silvanus* übereinstimmend, wenn auch die Funde sich nicht so lückenlos aneinander reihen: Assam, Malakka, Sumatra, Borneo und Java.

CYPHAGOGUS TABACICOLA Senna.

Cyphagogus tabacicola SENNA, Boll. Soc. Ent. Ital. 25 (1893) 294, T. 2, fig. 1, 1b.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*). MINDANAO, Provinz Lanao, Kolambugan (*Banks*).

Eine häufige und leicht erkennbare Art in derselben weiten Verbreitung wie die vorherigen: Indien, Malakka, grosse Sunda-Inseln, Andamanen.

CYPHAGOGUS WESTWOODI Parry.

Cyphagogus westwoodi PARRY, Trans. Ent. Soc. London 5 (1849) 182.

NEGROS, Cuernos Mountains (*Baker*).

Diese gemeine Art ist auf den Philippinen scheinbar nicht häufig, denn ich sah sie in dem grossen Material, das mir im Laufe der Jahre vorgelegen hat, nur dies eine mal. Die Verbreitung ist noch ausgedehnter als bei bisher besprochenen Arten. Von Ceylon bis zu den Philippinen ist sie lückenlos nachgewiesen und es ist die einzige mir bekannt gewordene *Cyphagogus*-Art, die aus Indo-China gameldet ist und die ich selbst von dort sah. Das Hauptverbreitungsgebiet ist allerdings Indien einschliesslich Bengalen, von wo sie fast mit jeder Bestimmungssendung kommt. Da die Hinterbeine ganz eigenartig gebildet sind, so ist keine Verwechslung mit anderen Arten möglich.

CYPHAGOGUS WHITEI Westwood.

Cyphagogus whitei WESTWOOD, Cab. Or. Ent. (1848) T. 15.

Eine ganz unklare Art, die nur von den Philippinen (?) bekannt sein soll. Ich konnte sie nach dem grossen Material, das ich im Laufe der Jahre gesehen habe, nicht identifizieren.

Von den 41 bekannten Arten kommen 12 auf den Philippinen vor. Sieht man von der unsicheren *whitei* ab, so bleibt nur eine Art, die, wenigstens bisher, auf den Inseln endemisch ist. Jedenfalls wird es aber so sein, dass Endemismen überhaupt nicht vorhanden sind.

Die Gattung *Cyphagogus* hat eine grosse Verbreitung. Von Ceylon bis Samoa lässt sie sich verfolgen. In Indien und auf den Sunda-Inseln hat sie eine ansehnliche Artenzahl entwickelt. In ihrem Grundcharakter ist die Gattung orientalisch, 27 Arten sind dahin zu zählen, 5 kommen in der orientalischen

und und papuanischen Region vor, der Rest ist östlich. Selbst in das Palaearktikum ist die Gattung vorgedrungen, bei Brenthiden ein seltener Fall.

Die *Cyphagogus* der Philippinen sind in ihrer Herkunft leicht zu deuten: sie sind wahrscheinlich alle von Westen her eingedrungen. Das ist umsomehr anzunehmen, als die Gattung grosse Aehnlichkeit mit *Cormopus* hat, diese liegt aber im Zentrum des westlichen Verbreitungskomplexes, in Zentralafrika. Zu Japan, Celebes oder gar Neu-Guinea bestehen keinerlei Beziehunge, von dort aus sind die Philippinen sicher nicht bevölkert worden. Die über Celebes hinausgegangenen sind zum grossen Teil in eine ganz andere Farbenentwicklung gekommen. Nur *modiglianii* bleibt unklar. Es ist indessen zu beachten, dass sich auch in Indien und auf den Sunda-Inseln, vernehmlich an den Rändern des Verbreitungskomplexes, bunte Arten finden. Diese sind aber nicht ohne weiteres mit den Australiern und Papuanern zu vergleichen, zeigen jedoch, dass die Tendenz, an den Randgebieten bunte Arten auszubilden, auffallend gross ist. So erklären sich auch die vielen bunten Arten in Australien und dem östlichen Archipel. Zu den weiten Wanderern aus dem Westen gehört auch *modiglianii;* er ist, wie die anderen *Cyphagogus* der Philippinen auch, mit dem grossen Strom gewandert und, wie es scheint, ein seltener Gast auf verlorenen Posten geblieben.

Genus EPIGOGUS Kleine

Epigogus KLEINE, Ent. Blätt. **19** (1923) 159.

EPIGOGUS FLEXIBILIS Kleine.

Epigogus flexibilis KLEINE, Ent. BLÄTT. **19** (1923) 159, fig. 1.

MINDANAO, Provinz Lanao, Kolambugan (*Boettcher*). NEGROS, Cuernos Mountains (*Baker, Schultze*). BASILAN (*Baker*). Endemische Art.

Genus ORTHOPAREIA Kleine

Orthopareia KLEINE, Philip. Journ. Sci. **28** (1925) 591.

ORTHOPAREIA IDONEA Kleine.

Orthopareia idonea KLEINE, Philip. Journ. Sci. **28** (1925) 592.

LUZON (*Weber*). Ohne nähere Fundortangabe. Endemische Art.

Beide Gattungen umfassen nur je eine Art, es sind also, wenigstens bis jetzt, auch die Gattungen endemisch.

Genus ASAPHEPTERUM Kleine

Asaphepterum KLEINE, Ent. Mitt. 1–4, **5** (1916) 85.

ASAPHEPTERUM FORMOSANUM Kleine.

Asaphepterum formosanum KLEINE, Ent. Mitt. 1–4, **5** (1916) 87, T. 1, figs. 13, 35–37.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*).

Diese eigenartige Gattung, die nur diese eine Art umfasst, fand ich zuerst zahlreich in Formosa–Ausbeuten. Sie ist aber weiter verbreitet. So sah ich Belegstücke von Borneo und Java, mit Ausnahme von Formosa aber immer nur einzeln.

Genus OPISTHENOXYS Kleine

Opisthenoxys KLEINE, Arch. Nat. A. 10, **87** (1921) 26.

OPISTHENOXYS BOETTCHERI Kleine.

Opisthenoxys boettcheri KLEINE, Philip. Journ. Sci. **28** (1925) 593.

MINDANAO, Provinz Zamboanga, Port Banga (*Boettcher*). Endemische Art.

OPISTHENOXYS OCHRACEUS Kleine.

Opisthenoxys ochraceus KLEINE, Arch. Nat. A. 10, **87** (1921) 28.

MINDANAO, Provinz Zamboanga, Zamboanga, Port Banga (*Boettcher*): Provinz Surigao, Surigao (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*), Fabrica (*Schultze*). BASILAN (*Baker*).

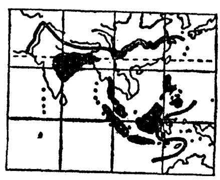

FIG. 3. Verbreitunskarte der Gattung *Opisthenoxys* Kleine.

Die Art ist häufig und recht weit verbreitet: Malayische Halbinsel, Sumatra, Borneo, Java. Die Verbreitung bewegt sich also auf derselben Linie wie die der meisten *Cyphagogus*.

Die Gattung umfasst 4 Arten; die hier nicht genannten kommen nur in Indien vor.

Genus PSEUDOCYPHAGOGUS Desbr.

Pseudocyphagogus DESBR., Journ. Asiat. Soc. Beng. 2, **59** (1890) 221.

PSEUDOCYPHAGOGUS SQUAMIFER Desbr.

Pseudocyphagogus squamifer DESBR., Journ. Asiat. Soc. Beng. 2, **59** (1890) 222.

NEGROS, Cuernos Mountains (*Baker*). SAMAR (*Baker*).

Diese einzige Art der Gattung ist von den Andamanen beschrieben worden und kommt dasalbst auch sehr häufig vor. Die

Verbreitung ist aber sehr viel grösser und bewegt sich auf der Linie der meisten orientalischen Zuwanderer. Mir lag Material vor von: Assam, Malakka, Sumatra, Borneo.

Genus MESODERES Senna

Mesoderes SENNA, Not. Leyd. Mus. **20** (1898) 65.

MESODERES FESSUS Kleine.

Mesoderes fessus KLEINE, Ent. Blätt. **19** (1923) 160.

NEGROS, Cuernos Mountains (*Baker.*) Endemische Art.

Von den 8 bekannten Arten leben in Indien 2, Malakka 2, Buru 1, zwei kommen von Malakka bis Neu-Guinea vor.

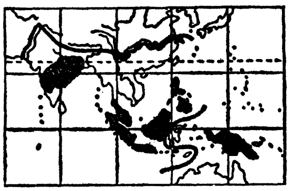

FIG. 4. Verbreitungskarte der Gattung *Mesoderes* Senna.

Ohne Zweifel ist die Gattung in ihrem Grundcharakter orientalisch. Der Zug gegen Osten ist gut zu verfolgen. Die beiden nicht endemischen Arten mit grosser Migration lassen deutlich erkennen, dass kein sprunghaftes Vordringen stattgefunden hat, denn beide sind auf allen grossen Sunda-Inseln nachzuweisen. Vielleicht finden sich auch auf den Molukken noch einige Arten an.

Genus ATOPOMORPHUS Kleine

Atopomorphus KLEINE, Philip. Journ. Sci. **28** (1925) 593.

ATOPOMORPHUS SCHULTZEI Kleine.

Atopomorphus schultzei KLEINE, Philip. Journ. Sci. **28** (1925) 594, t. 1, figs. 1–3.

NEGROS, Fabrica (*Schultze*).

Nur diese eine, auf den Philippinen endemische, Art ist bekannt.

Genus ETEROZEMUS Senna

Eterozemus SENNA, Boll. Soc. Ent. Ital. **34** (1902) 160.

ETEROZEMUS LAETUS Senna.

Eterozemus laetus SENNA, Ann. Mus. Genova (2) **12** (32) (1892) 441.

LUZON, Provinz Nueva Vizcaya, Imugan (*Baker*).

Weitere sichere Fundorte sind bekannt von Burmah, Sumatra, Java. Sicher sind die dazwischen liegenden Gebiete auch bewohnt, mir lagen aber von der, nicht gerade häufigen, Art keine Belegstücke vor.

ETEROZEMUS PUBENS Senna.

Eterozemus pubens SENNA, Ann. Mus. Genova (2) 12 (32) (1892) 439.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*).

Mir lagen Stücke vor von: Burmah, Perak, Formosa, Java. Die Verbreitung beider Arten wird wahrscheinlich sehr gleichmässig sein. Ueber das Verbreitungszentrum der Gattung lässt sich nichts sicheres sagen, da beide Arten immer nur einzeln gefunden werden. Nur diese beiden Arten sind bekannt.

Genus DICTYOTOPTERUS Kleine

Dictyotopterus KLEINE, Ent. Mitt. 1–4, 5 (1916) 75.

DICTYOTOPTERUS PHILIPPINENSIS Kleine.

Dictyotopterus philippinensis KLEINE, Arch. Nat. A. 10, 87 (1921) 25.

Philippinen ohne nähere Fundortangabe.

DICTYOTOPTERUS PULCHERRIMUS Kleine.

Dictyotopterus pulcherrimus KLEINE, Arch. Nat. A. 10, 87 (1921) 26.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*). Ausserdem sah ich mehere Belegstücke ohne näheren Fundort.

Es sind drei Arten bekannt. Ausser den beiden genannten lebt eine Art auf Formosa und den Andamanen. *Dictyotopterus* entfernt sich also von der grossen Strasse, auf der wir schon die meisten Zuwanderer kommen sahen, nicht.

Alle auf den Philippinen gefundenen Calodromini sind rein orientalischen Charakters und müssen als Zuwanderer angesehen werden. Zwar sind einige, artenarme, Gattungen nur auf den Philippinen als endemisch festgesteket, aber das will wenig besagen, da die Abstammung von Orientalen sicher ist.

STEREODERMINI

Genus JONTHOCERUS Lacordaire

Jonthocerus LACORDAIRE, Gen. Col. 7 (1866) 415.

JONTHOCERUS ASIATICUS Kleine.

Jonthocerus asiaticus KLEINE, Arch. Nat. A. 8, 85 (1919) 47, figs. 12, 13.

LUZON (ohne nähere Angabe). MINDANAO, Provinz Davao Davao: Provinz Agusan, Butuan (*Baker*). PALAWAN, Puerto Princesa (Sammler unbekannt).

Die Art fand ich ferner aus Material von: Formosa, Sumatra, Borneo. Ich sah einen *Jonthocerus* aus Ceylon, der vielleicht

TABELLE 3.—*Verbreitungstabelle der Calodromini.*

	Ceylon.	Indien.	Bengalen.	Indo-China.	Formosa.	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Andamanen.	Molukken.	Australien.
Calodromus crinitus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Calodromus mellyi Guérin	—	+	+	—	—	+	+	+	—	—	—	—
Cyphagogus buccatus Kleine	+	+	+	—	—	+	+	+	+	+	—	—
Cyphagogus eichhorni Kirschbaum	—	—	+	—	—	+	+	+	—	—	+	—
Cyphagogus gladiator Kleine	—	—	+	—	—	+	+	+	—	—	—	—
Cyphagogus humilis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Cyphagogus longulus Senna	—	—	—	—	—	+	—	—	+	—	+	—
Cyphagogus modiglianii Senna	—	—	—	—	—	+	+	—	—	—	—	+
Cyphagogus planifrons Kirschbaum	—	+	+	—	—	+	+	+	+	—	—	—
Cyphagogus silvanus Senna	—	+	—	—	—	+	+	+	+	—	+	—
Cyphagogus simulator Senna	—	—	+	—	—	+	+	+	+	—	—	—
Cyphagogus tabacicola Senna	—	+	+	—	—	+	+	+	+	+	—	—
Cyphagogus westwoodi Parry	+	+	+	+	—	+	+	+	+	—	—	—
Cyphagogus whitei Westwood [a]	—	—	—	—	—	—	—	—	—	—	—	—
Epigogus flexibilis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Orthopareia idonea Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Asaphepterum formosanum Kleine	—	—	—	—	+	—	—	+	+	—	—	—
Opisthenoxys boetteheri Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Opisthenoxys ochraceus Kleine	—	—	—	—	—	+	+	+	+	—	—	—
Pseudocyphagogus squamifer Desbr	—	—	+	—	—	+	+	+	—	+	—	—
Mesoderes fessus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Atopomorphus schultzei Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Eterozemus lætus Senna	—	—	+	—	—	—	+	+	+	—	—	—
Eterozemus pubens Senna	—	—	+	—	+	+	—	—	+	—	—	—
Dictyotopterus philippinensis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—
Dictyotopterus pulcherrimus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—

[a] Endemisch.

hierher gehören könnte. Ich bezweifle aber die Zugehörigkeit, da nicht einmal von der Malayischen Halbinsel ein Belegstüch vorlag. Das übrige Verbreitungsgebiet ist gut abgeschlossen. Der Uebergang von Borneo nach den Philippinen über Palawan ist interessant. Ueber diese Brücke sind sicher sehr viele Arten gewandert.

JONTHOCERUS BICOLOR K. M. Heller.

Jonthocerus bicolor K. M. HELLER, Deutsche Ent. Zeit. (1916) 297.

LUZON, Provinz Laguna, Mount Banahao (*Baker*).

Endemische Art. Die Art ist dadurch wichtig, dass sie die Ausfärbung der Neu-Guinea-Tiere besitzt. Das kommt auf den Philippinen öfter vor, in dieser Gattung ist es aber die einzige Art. Von Neu-Guinea selbst ist kein *Jonthocerus* bekannt.

JONTHOCERUS LATICOSTATIS Kleine.

Jonthocerus laticostatis KLEINE, Arch. Nat. A 8, **85** (1919) 38, figs. 4, 5.

MINDANAO, Lanao, Iligan, Kolambugan (*Baker*).

Ich sah die Art ferner von Formosa, Sumatra, Borneo. Es ist sehr wahrscheinlich, dass sie westlich bis zur Malayischen Halbinsel zu finden ist. Die Verbreitung dürfte sich mit *asiaticus* ziemlich decken.

JONTHOCERUS MODIGLIANII Senna.

Jonthocerus modiglianii SENNA, Ann. Mus. Genova (2) **19** (39) (1898) 228.

MINDANAO, Provinz Agusan, Butuan (*Baker*).

Weitere Verbreitung: Andamanen, Sumatra, Mentawei.

Die Gattung umfasst 18 Arten von denen 14 orientalisch sind. Das Verbreitungszentrum liegt auf den grossen Sunda-Inseln; von hier aus strahlt die Gattung über Formosa bis Japan aus. Aus Indien habe ich nur einen recht schwachen Besatz gesehen, aber, und das ist wichtig, die Verbreitung ist bis Ceylon, wo noch eine endemische Art vorkommt, nicht unterbrochen. Das grosse Areal das die Gattung bewohnt ist daran zu erkennen, dass sowohl in Afrika wie in Australien je zwei Arten leben. Der Gattungstyp ist sehr einheitlich.

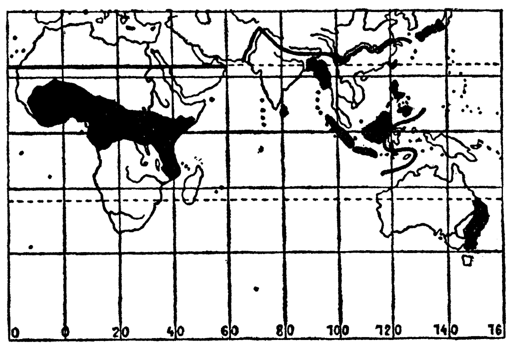

FIG. 5. Verbreitungskarte der Gattung *Jonthocerus* Lacord.

Genus STEREODERMUS Lacordaire

Stereodermus LACORDAIRE, Gen. Col. 7 (1866) 419.

STEREODERMUS FLAVOTIBIALIS Kleine.

Stereodermus flavotibialis KLEINE, Arch Nat. A. 10, **87** (1921) 28.

LUZON, Provinz Laguna, Mount Maquiling: Provinz Tayabas, Malinao (*Baker*).

Endemische Art. Die Gattung ist in der Hauptmasse ihrer Arten neotropisch, 18 von 25 leben hauptsächlich in Zentral-Amerika, eine geht bis Südbrasilien, 6 sind von Senna von den

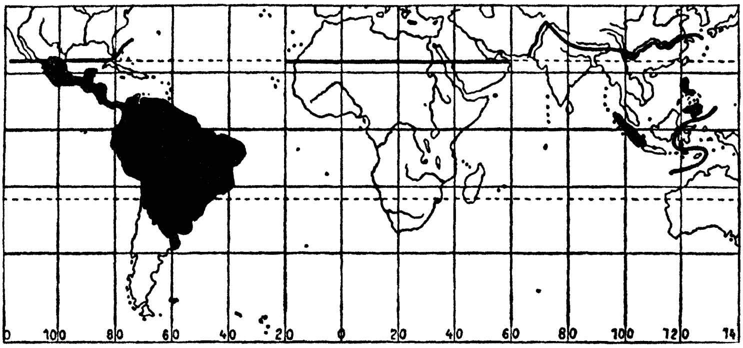

FIG. 6. Verbreitungskarte der Gattung *Stereodermus* Lacord.

Sunda-Inseln beschrieben und ein ist auf den Philippinen endemisch. Die Zugehörigkeit aller Arten zur Gattung erscheint mir hinreichend gesichert. Die Stereodermini sind in allen grossen Gattungen auffällig weit verbreitet (cfr. *Cerobates*).

Genus CEROBATES Schoenherr

Cerobates SCHOENHERR, Gen. Curc. 5 (1840) 487.

CEROBATES ADUSTUS Senna.

Cerobates adustus SENNA, Not. Leyd. Mus. 16 (1894) 184.

MINDANAO, Provinz Lanao, Iligan (*Baker*).

Eine Art von ausserordentlich weiter Verbreitung: Ceylon, Assam, Malayische Halbinsel, Sumatra, Borneo, Java, Nias, Bali, Neu-Guinea, Fiji-Inseln. Die Art steht in der Verbreitung nicht allein da (cfr. *sexsulcatus* und *tristriatus*).

CEROBATES ÆQUALIS Kleine.

Cerobates æqualis KLEINE, Arch. Nat. A. 3, 87 (1922) 203.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*), Paete (*Boettcher*): Provinz Bataan, Lamao (*Boettcher*). MINDANAO, Provinz Lanao, Mumungan (*Boettcher*): Provinz Zamboanga, Port Banga (*Boettcher*). SAMAR, Catbalogan (*Boettcher*).

Auch diese Art hat eine sehr weite Verbreitung: Ceylon, Indien, Indo-China, Malayische Halbinsel, Sumatra, Borneo, Java, Andamanen, Nicobaren, Ternate. Gegen Osten ist *æqualis* nicht so weit vorgedrungen wie *adustus*.

CEROBATES ANGUSTIPENNIS Senna.

Cerobates angustipennis SENNA, Not. Leyd. Mus. 16 (1894) 182.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*).

Bisher nur von Java gemeldet. Sehr wahrscheinlich ist die Art aber, wie die meisten, viel weiter verbreitet und nur noch nicht aufgefunden worden.

CEROBATES CLINATUS Kleine.

Cerobates clinatus KLEINE, Treubia 3–4, 3 (1923) 405.

MINDANAO, Provinz Zamboanga, Port Banga (*Boettcher*).
Das bei *angustipennis* Gesagte gilt auch hier.

CEROBATES COSTATUS Kleine.

Cerobates costatus KLEINE, Philip. Journ. Sci. 20 (1922) 153, t. 1, fig. 2.

MINDANAO, Provinz Surigao, Surigao (*Baker*). Endemische Art.

CEROBATES FORMOSANUS von Schönfeldt.

Cerobates formosanus VON SCHÖNFELDT, Deutsche Ent. Nat. Bibl. No. 24 2 (1911) 190.

LUZON, Provinz Laguna, Mount Banahao, Los Baños (*Boettcher*): Subprovinz Kalinga, Balbalasan (*Boettcher*). MINDANAO, Provinz Lanao, Mumungan (*Baker*). NEGROS, Cuernos Mountains (*Baker*).

Von Schönfeldt hat die Art aus Formosa-Material beschrieben. Auf den Philippinen ist sie aber wenigstens ebenso stark vertreten wie auf Formosa selbst. Sonst sah ich die Art nicht, sie schein also auf diesen, verhältnismässig kleinen, Verbreitungskreis beschränkt zu sein.

CEROBATES GROUVELLEI Senna.

Cerobates grouvellei SENNA, Boll. Soc. Ent. Ital. 3, 15 (1893) 307, t. 2, fig. 6.

MINDANAO, Provinz Zamboanga, Dapitan (*Baker*).

Die Art ist sehr weit verbreitet, wenn sich auch kein lückenloser Zusammenhang nachweisen lässt. Ich sah Material von: Sumatra, Borneo, Bali, Queensland.

CEROBATES SEXSULCATUS Motschulsky.

Cerobates sexsulcatus MOTSCHULSKY, Et. Ent. 7 (1858) 95.

LUZON, Provinz Laguna, Los Baños, Paete (*Boettcher*). MINDANAO, Provinz Zamboanga, Port Banga (*Boettcher*): Provinz Surigao, Surigao, Dapa (*Boettcher*): Provinz Bukidnon, Tangkulan (*Baker*): Provinz Lanao, Kolambugan (*Baker*): MASBATE, Aroroy, Cabugao (*Boettcher*). BASILAN (*Baker*).

Eine der gemeinsten und weitverbreitetsten Arten, die genau erkennen lässt, wie man sich das Wohngebiet der Gattung, soweit sie nicht aethiopisch ist, zu denken hat. Es lagen mir Belegstücke vor von: Ceylon, Indien, Malayische Halbinsel, Sumatra, Borneo, Java, Sumbawa, Insel Batu, Andamanen, Cochin-China, Celebes, Molukken, Neu-Guinea, Queensland.

CEROBATES SUMATRANUS Senna.

Cerobates sumatranus SENNA, Boll. Soc. Ent. Ital. 3, 25 (1893) 306, t. 3, fig. 1.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*). MINDANAO, Provinz Zamboanga, Port Banga (*Boettcher*): Provinz Lanao, Mumungan (*Boettcher*).

Verbreitung der vorigen Art ähnlich: Ceylon, Indien, Malayische Halbinsel, Indo-China, Sumatra, Borneo, Java, Mentawei, Timor, Formosa, Celebes. Da bereits Celebes und die kleinen Sunda-Inseln erreicht sind ist zu erwarten, dass *sumatranus* noch weiter östlich gefunden wird.

CEROBATES TRISTRIATUS Fabricius.

Cerobates tristriatus FABRICIUS, Syst. El. 2 (1801) 554.

LUZON, Provinz Ilocos Norte, Bangui (*Banks*): Provinz Laguna, Mount Banahao, Mount Maquiling (*Baker*), Magdalena (*Schultze*), Paete (*Boettcher*): Provinz Nueva Vizcaya, Imugan (*Boettcher*): Provinz Bataan, Lamao (*Boettcher*), Cabugao (*Boettcher*); Malinao (*Baker*). MINDANAO, Provinz Agusan, Cabadbaran (*Weber*): Provinz Lanao, Mumungan (*Boettcher*): Provinz Zamboanga, Port Banga (*Boettcher*). SIARGAO, Dapa (*Boettcher*). BASILAN (*Boettcher*). SAMAR (*Baker*).

Verbreitung also gleich *sexsulcatus*.

Von den 37 Arten dieser Gattung gehören 15 der aethiopischen Region an und scheiden ganz aus, 2 sind als australisch anzusehen, 20 sind orientalisch, ganz gleich, wie weit die Verbreitung gegen Osten stattgefunden hat. Der Habitus ist so einheitlich, dass Zweifel über die Zugehörigkeit zur Gattung ausgeschlossen sind. Die Stereodermini sind ganz allgemein durch grosse Migration ausgezeichnet. Wenigstens gilt das für die artenreichen Gattungen.

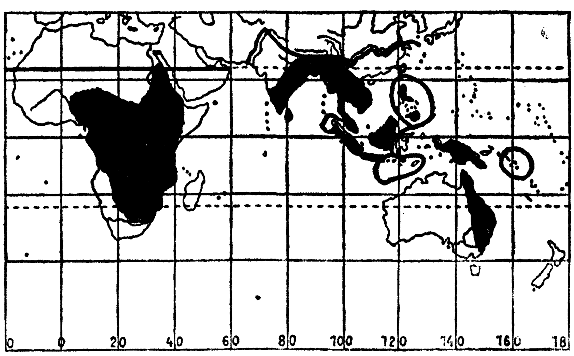

FIG. 7. Verbreitungskarte der Gattung *Cerobates* Schoenherr.

TABELLE 4.—*Verbreitungstabelle der Stereodermini.*

	Ceylon.	Indien.	Bengalen.	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Indo-China.	Formosa.	Andamanen.	Mentawei.	Celebes.	Molukken.	Neu-Guinea.	Australien.	Polynesien.
Jonthocerus asiaticus Kleine	—	—	—	—	+	+	—	—	+	—	—	—	—	—	—	—
Jonthocerus bicolor Heller [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jonthocerus laticostatis Kleine	—	—	—	—	+	+	—	—	+	+	+	—	—	—	—	—
Jonthocerus modiglianii Senna	—	—	—	—	+	—	—	—	—	+	+	—	—	—	—	—
Stereodermus flavotibialis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cerobates adustus Senna	+	+	+	+	+	+	+	—	—	—	—	—	—	+	—	+
Cerobates aequalis Kleine	+	+	+	+	+	+	+	+	—	+	+	—	+	—	—	—
Cerobates angustipennis Senna	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Cerobates clinatus Kleine	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Cerobates costatus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cerobates formosanus von Schönfeldt	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
Cerobates grouvellei Senna	—	—	—	—	+	+	—	—	—	—	—	—	—	—	+	—
Cerobates sexsulcatus Motschulsky	+	+	+	+	+	+	+	+	—	+	+	+	+	+	+	—
Cerobates sumatranus Senna	+	+	+	+	+	+	+	+	+	+	—	+	—	—	—	—
Cerobates tristriatus Fabricius	+	+	+	+	+	+	+	—	—	+	+	+	—	+	+	—

[a] Endemisch.

TRACHELIZINI

Genus HOMOPHYLUS Kleine

Homophylus KLEINE, Zool. Meded. Leid. 5 (1920) 244.

HOMOPHYLUS MINDANENSIS Kleine.

Homophylus mindanensis KLEINE, Philip. Journ. Sci. 28 (1925) 595.

MINDANAO, Surigao, Surigao (*Boettcher*). Endemische Art. Zwei weitere Arten sind von Java bekannt.

Genus METATRACHELIZUS Kleine

Metatrachelizus KLEINE, Arch. Nat. A. 3, 88 (1922) 207.

METATRACHELIZUS CONSTANS Kleine.

Metatrachelizus constans KLEINE, Capita Zool. 4, 2 (1926) 20, t. 1, fig. 27.

SIARGAO, Dapa (*Boettcher*).

Ausserdem von Mysol bekannt.

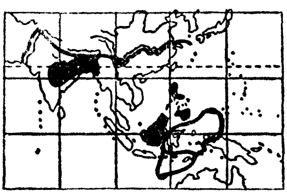

FIG. 8. Verbreitungskarte der Gattung *Metatrachelizus* Kln.

Uber das wirkliche Verbreitungsaraeal der Gattung lässt sich nichts Sicheres sagen. Von den 7 Arten sind 4 auf den Molukken, 2 in Indien und 1 auf Borneo gefunden worden. Der stärkere Artbestand auf den Molukken ist immerhin auffällig und lässt das Verbreitungszentrum nicht erkennen. Es besteht eine weitläufige Verwandtschaft mit den Stereodermini, vielleicht hängt die starke eigung zur Migration damit zusammen.

Genus TRACHELIZUS Schoenherr

Trachelizus SCHOENHERR, Gen. Curc. 5 (1840) 489.

TRACHELIZUS BISULCATUS Fabricius.

Brentus bisulcatus (FABRICIUS), Syst. El. 2 (1801) 548.

LUZON, Provinz Laguna, Mount Maquiling, Malinao (*Baker*); Mount Banahao (*Boettcher*): Provinz Bataan, Lamao (*Boettcher*): Provinz Nueva Vizcaya, Imugan (*Boettcher*). MINDANAO, Provinz Zamboanga, Dapitan (*Baker*): Provinz Lanao, Iligan, Kolambugan (*Baker*); Mumungan (*Boettcher*): Provinz Bukidnon, Tangkulan (*Baker*). LEYTE, Burauen (*Boettcher*). BASILAN (*Boettcher*). SAMAR (*Baker*).

Der gemeinste Brenthide überhaupt. Von Ceylon bis zu den Salomonen, von Japan bis Queensland. Die Gattung umfasst

11 Arten, von denen keine auch nur entfernt so grosse Migration aufweist, im Gegenteil, die meisten haben einen kleinen Verbreitungskreis über den sie nicht hinausgehen. Dabei fällt die Einheitlichkeit im Habitus auf, Stücke von Ceylon sehen genau so aus wie von Australien, den Salomonen oder Japan.

Genus MIOLISPA Pascoe

Miolispa PASCOE, Journ. Ent. 1 (1862) 393.

MIOLISPA BICOLOR Kleine.

Miolispa bicolor KLEINE, Stett. Ent. **80** (1919) 316, fig. 54.

LUZON, Provinz Laguna, Mount Banahao, Mount Maquiling (*Baker*): Provinz Nueva Vizcaya, Imugan (*Weber*). MINDANAO, Provinz Lanao, Mumungan (*Boettcher*): Provinz Surigao, Surigao (*Baker*). MINDORO, Subaan (*Boettcher*). SAMAR (*Baker*). Endemische Art mit Färbung des Neu-Guineatypus.

MIOLISPA CLAVICORNIS Kleine.

Miolispa clavicornis KLEINE, Arch. Nat. A. 10, **87** (1921) 30.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*): Provinz Nueva Vizcaya, Imugan (*Boettcher*). MINDANAO, Provinz Agusan, Butuan (*Baker*): Provinz Surigao, Surigao (*Boettcher*): Provinz Lanao, Mumungan (*Boettcher*). SIBUYAN (*Baker*). Endemische Art.

MIOLISPA CRUCIATA Senna.

Miolispa cruciata SENNA, Not. Leyd. Mus. **20** (1898) 69.

MINDANAO, Provinz Davao, Davao, (*Baker*): Provinz Agusan, Butuan (*Baker*): Provinz Lanao, Mumungan (*Boettcher*).

Ich sah die Art ferner von Sumatra, Borneo und Formosa. Sie ist nicht gerade selten; der Verbreitungsbezirk ist aber nicht sehr gross.

MIOLISPA DISCORS Senna.

Miolispa discors SENNA, Ann. Soc. Ent. Belg. **39** (1895) 358.

MINDANAO, Provinz Lanao, Iligan, Cotabato (*Taylor; Baker*). NEGROS, Cuernos Mountains (*Baker*).

Die Verbreitung ist der vorigen Art ähnlich und nur etwas ausgedehnter: Penang, Borneo, Formosa, Celebes. Sicher ist sie auch auf Sumatra zu finden, doch hat mir kein Belegstück vorgelegen. Interessant ist der Fund von Celebes, mit dieser Insel besteht öfter Uebereinstimmung der Arten.

MIOLISPA ELONGATA Kleine.

Miolispa elongata KLEINE, Stett. Ent. Zeit. **80** (1919) 244, figs. 13–17.

LUZON, Manila (Sammler unbekannt). MINDANAO, Provinz Surigao, Surigao (*Baker*): Provinz Lanao, Mumungan, Kolambugan (*Boettcher*): Provinz Zamboanga, Zamboanga (*Baker*): Provinz Bukidnon, Tangkulan (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*). BASILAN (*Baker*). PANAON (*Baker*).

Baker hat die Art ferner im nördlichen Borneo gesammelt. Der Verbreitungsbezirk scheint aber nur begrenzt zu sein und die Art muss in erster Linie als philippinisch angesprochen werden. Wenn sie auf Borneo häufiger wäre, hätte sie sich unter dem grossen Material das ich von Kina Balu gesehen habe wohl schon einmal gefunden, das ist aber nicht der Fall gewesen.

MIOLISPA EPHIPPIUM Kleine.

Miolispa ephippium KLEINE, Stett. Ent. Zeit. **80** (1919) 247, fig. 18.

LUZON, Provinz Tayabas, Malinao (*Baker*).

Endemische Art. Mir lagen später noch öfter Belegstücke vor, leider ohne näheren Fundort.

MIOLISPA FLAVOLINEATA Kleine.

Miolispa flavolineata KLEINE, Stett. Ent. Zeit. **80** (1919) 282, fig. 37.

LUZON, Provinz Laguna, Mount Banahao, Mount Maquiling (*Baker*): Provinz Nueva Vizcaya, Imugan (*Boettcher*). MINDANAO, Provinz Lanao, Iligan, Kolambugan (*Baker*). BASILAN (*Baker*). Endemische Art.

MIOLISPA FLEXILIS Kleine.

Miolispa flexilis KLEINE, Ent. Blätt. **19** (1923) 161.

SAMAR (*Baker*). MINDANAO, Provinz Agusan, Butuan (*Baker*): Provinz Lanao, Mumungan (*Boettcher*): Provinz Surigao, Surigao (*Boettcher*). Endemische Art.

MIOLISPA FORMOSA Kleine.

Miolispa formosa KLEINE, Ent. Blätt. **19** (1923) 160, figs. 2, 3.

MINDANAO, Provinz Agusan, Butuan (*Baker*). Endemische Art.

MIOLISPA FORNICATA Kleine.

Miolispa fornicata KLEINE, Ent. Blätt. **19** (1923) 161.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*): Provinz Nueva Vizcaya, Imugan (*Boettcher*). MINDANAO, Provinz

Lanao, Mumungan (*Boettcher*); Provinz Surigao, Surigao (*Boettcher*). LEYTE, Burauen (*Boettcher*). Endemische Art.

MIOLISPA FRAUDATRIX Kleine.

Miolispa fraudatrix KLEINE, Stett. Ent. Zeit. **80** (1919) 249, fig. 19.

LUZON, Provinz Tayabas, Malinao (*Baker*). Endemische Art.

MIOLISPA INTERMEDIA Senna.

Miolispa intermedia SENNA, Ann. Soc. Ent. Belg. **41** (1897) 239.

MINDANAO, Provinz Lanao, Iligan (*Baker*): Provinz Surigao, Surigao (*Baker*).

Die Art ist nicht häufig aber doch recht weit verbreitet. Mir lagen Belegstücke vor von: Borneo, Java, Celebes und den Molukken (Amboina).

MIOLISPA LINEATA Senna.

Miolispa lineata SENNA, Not. Leyd. Mus. **20** (1898) 57.

MINDANAO, Provinz Agusan, Butuan (*Baker*).

Die Verbreitung dieser Art ist sicher nur ganz mangelhaft bekannt. Von Java sah ich sie sehr häufig und zwar von allen Teilen der Insel. Sie kommt auch auf der Malayischen Halbinsel vor, woraus zu schliessen ist, dass sie wenigstens auf Sumatra leben muss.

MIOLISPA PASCOEI Kleine.

Miolispa pascoei KLEINE, Stett. Ent. Zeit. **80** (1919) 226.

LUZON, Provinz Laguna, Mount Maquiling, Mount Banahao (*Baker*): Provinz Tayabas, Malinao (*Baker*). MINDANAO, Provinz Agusan, Butuan (*Baker*): Provinz Lanao, Iligan (*Baker*). Endemische Art.

MIOLISPA PAUCICOSTATA Kleine.

Miolispa paucicostata KLEINE, Stett. Ent. Zeit. **80** (1919) 312, fig. 52.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*). Endemische, seltene Art.

MIOLISPA PERSIMILIS Kleine.

Miolispa persimilis KLEINE, Philip. Journ. Sci. **20** (1922) 154, t. 1, fig. 3.

MINDANAO, Provinz Lanao, Kolambugan (*Baker*); Mumungan (*Boettcher*). Endemische Art.

MIOLISPA PULCHELLA Kleine.

Miolispa pulchella KLEINE, Arch. Nat. A. 10, **87** (1921) 29.

LUZON, Subprovinz Benguet, Baguio (*Baker*): Provinz Laguna, Mount Maquiling (*Baker*): Provinz Nueva Vizcaya, Imugan (*Banks, Boettcher*).

MIOLISPA ROBUSTA Kleine.

Miolispa robusta KLEINE, Stett. Ent. Zeit. **80** (1919) 230, fig. 8.

LUZON, Provinz Laguna, Los Baños, Mount Banahao (*Boettcher*). CATANDUANES, Virac (*Boettcher*). MINDANAO, Provinz Davao, Davao, (*Baker*): Provinz Surigao, Surigao (*Baker*): Provinz Agusan, Butuan (*Baker*): Provinz Lanao, Kolambugan, Iligan (*Baker*); Mumungan (*Boettcher*); San Miguel (*Boettcher*). MINDORO, Subaan (*Boettcher*). SIARGAO, Dapa (*Boettcher*). POLILLO (*Boettcher*). SAMAR (*Baker*). BASILAN (*Baker*).

Die Art ist sicher auf den Philippinen zu Hause. Das Auffinden auf Borneo (Sandakan) durch Baker beweist mir, dass die Verbreitung nur gering ist, sonst wären weitere Funde nachgewiesen. (cfr. *elongata*).

MIOLISPA SIPORABA Senna.

Miolispa siporaba SENNA, Ann. Mus. Genova (2) **19** (39) (1898) 233.

MINDANAO, Surigao, Surigao (*Baker*).

Eine der verbreitetsten Arten, die sich schon deutlich auf dem mehrfach skizzierten Wege von Westen nach Osten bewegt. Ich sah sichere Belegstücke von Malakka, Sumatra, Mentawei, Borneo, Java und den Molukken.

MIOLISPA UNICOLOR Kleine.

Miolispa unicolor KLEINE, Stett. Ent. Zeit. **80** (1919) 314, fig. 53.

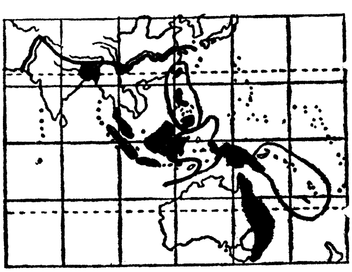

FIG. 9. Verbreitungskarte der Gattung *Miolispa* Pascoe.

LUZON, Provinz Laguna, Mount Banahao (*Baker*): Provinz Nueva Vizcaya, Imugan (*Boettcher*). Endemische Art.

Die Gattung *Miolispa* ist die artenreichste der ganzen Familie. Von den bekannten 65 Arten kommen 20 auf den Philippinen vor und davon 13 als Endemismen. Von den restlichen 8 müssen wenigstens noch 2 (*elongata* und *robusta*) als Philippinentiere angesprochen werden. Nur einige

lassen den bekannten Weg aus dem östlichen Verbreitungszentrum erkennen.

Das Verbreitungsareal der Gattung ist gross. Ceylon und Indien haben merkwürdigerweise keine Vertreter. Erst in Burmah finden sich die ersten Spuren, die aber auch nur als Ausläufer anzusehen sind. Das Verbreitungszentrum liegt auf dem südlichen Teil der Malayischen Halbinsel und den grossen Sunda-Inseln. Von hier aus ist starke Abwanderung sowohl nach den Philippinen wie nach Celebes und ins austro-malayische und australische Gebiet festzustellen. Bemerkenswert ist für die Gattung die Tatsache, dass sich so zahlreiche Arten mit kleinem Verbreitungskreis gebildet haben. Neigung zur Variation ist allgemein gering.

Genus HYPOMIOLISPA Kleine

Hypomiolispa KLEINE, Ent. Blätt. 14 (1918) 163.

HYPOMIOLISPA EXARATA Desbr.

Hypomiolispa exarata DESBR., Journ. Asiat. Soc. Beng. 2, Nat. Sc. No. 3 (1890) 223.

MINDANAO, Provinz Zamboanga, Zamboanga (*Baker*): Provinz Lanao, Iligan (*Baker*): Provinz Surigao, Surigao (*Baker*). SAMAR (*Baker*). BASILAN (*Baker*).

Ausser auf den Philippinen, Sumatra, Borneo und Java gefunden. Auf Sumatra und Java ist die Art sehr häufig, auf Borneo lässt die Besatzstärke näch und die Philippinen können nur noch als vorgeschobener Posten angesehen werden.

HYPOMIOLISPA HELLERI Kleine.

Hypomiolispa helleri KLEINE, Ent. Blätt. 14 (1918) 329.

MINDANAO, Provinz Davao, Davao (*Baker*): Provinz Surigao, Surigao (*Baker*). BASILAN (*Baker*). Endemische Art.

HYPOMIOLISPA NUPTA Senna.

Hypomiolispa nupta SENNA, Not. Leyd. Mus. 14 (1892) 171.

LUZON, Provinz Tayabas, Malinao (*Baker*). MINDANAO, Provinz Lanao, Kolambugan, Mumungan (*Boettcher*): Provinz Agusan, Butuan (*Baker*).

Eine der verbreitetsten Arten auf der West-Ost-Strasse sehr gut nachweisbar: Assam, Malayische Halbinsel, Sumatra, Borneo, Java, Mentawei.

HYPOMIOLISPA OCULARIS Kleine.

Hypomiolispa ocularis KLEINE, Proc. Hawaiian Ent. Soc. (1) 7 (1927) (1928) 57, figs. 2, 3.

LUZON, Provinz Laguna, Los Baños (Sammler unbekannt). Endemische Art.

HYPOMIOLISPA SPONSA Kleine.

Hypomiolispa sponsa KLEINE, Ent. Blätt. 14 (1918) 324.

MINDANAO, Provinz Surigao, Surigao (*Baker*): Provinz Lanao, Mumungan (*Boettcher*). SAMAR (*Baker*).

Diese mit *nupta* verwandte Art hat fast dieselbe Verbreitung: Malayische Halbinsel, Sumatra, Borneo, Java, Mentawei; die Westgrenze scheint aber schon in Selangor zu liegen.

HYPOMIOLISPA TOMENTOSA Kleine.

Hypomiolispa tomentosa KLEINE, Philip. Journ. Sci. 20 (1922) 156.

MINDANAO, Provinz Lanao, Iligan (*Baker*). Endemische Art.

HYPOMIOLISPA TRACHELIZOIDES Senna.

Hypomiolispa trachelizoides SENNA, Not. Leyd. Mus. 16 (1894) 193.

MINDANAO, Provinz Agusan, Butuan (*Baker*): Provinz Lanao, Iligan (*Baker*); Mumungan (*Boettcher*). SAMAR (*Baker*).

Verbreitung gleich *sponsa*, ausserdem noch auf Celebes gefunden. Verbreitungszentren sind die grossen Sunda-Inseln mit Sumatra als Hauptinsel.

Die Gattung umfasst 32 Arten. Mit *Miolispa* besteht einige, wenn auch entfernte, Verwandtschaft. Einige Arten waren früher bei *Miolispa* untergebracht. Ganz zu Unrecht. Die zoogeographischen Verhältnisse sind in beiden Gattungen total verschieden. *Miolispa* ist stark nach Osten, *Hypomiolispa* nach Westen orientiert. Nur im Verbreitungszentrum beider Gattungen, den Sunda-Inseln, treffen sie in etwa gleicher Stärke zusammen. In der auf den Philippinen festgestellten Artenzahl dokumentiert sich das Gesagte. Während *Miolispa* noch mit der ansehnlichen Zahl von 20 Arten vorkommt, hat es *Hypomiolispa* nur auf 7 gebracht, davon 2 Endemismen. Auf den Philippinen liegt auch die Ostgrenze der Verbreitung, nach Südosten ist die Gattung nicht vorgedrungen, Färbungselemente die auf Neu-Guinea hinweisen und die sich in der Gattung Miolispa mehrfach finden, fehlen ganz.

Genus HIGONIUS Lewis

Higonius LEWIS, Journ. Linn. Soc. Lond. Zool. **17** (1883) 299.

HIGONIUS CILO Lewis.

Higonius cilo LEWIS, Journ. Linn. Soc. Lond. Zool. **17** (1883) 300, t. 12, figs. 9, 10.

LUZON, Subprovinz Kalinga, Balbalasan (*Boettcher*). MASBATE, Aroroy (*Boettcher*).

Die Verbreitung dieser Art ist eigenartig: Indien, Burmah, Formosa, Japan. Von den Sunda-Inseln und Malakka, von wo ich so viel Material gesehen habe, ist sie mir niemals vorgekommen. Andere Arten, zum Beispiel, *crux,* haben sich auf dieser Strasse ausgebreitet. *Higonius* ist rein orientalisch.

Genus MICROTRACHELIZUS Senna

Microtrachelizus SENNA, Boll. Soc. Ent. Ital. **25** (1893) 315.

MICROTRACHELIZUS FLUXUS Kleine.

Microtrachelizus fluxus KLEINE, Ent. Blätt. **19** (1923) 162.

NEGROS, Cuernos Mountains (*Baker*). Endemische Art.

MICROTRACHELIZUS PUBESCENS Senna.

Microtrachelizus pubescens SENNA, Boll. Soc. Ent. Ital. **25** (1893) 320, t. 3, fig. 6.

NEGROS, Cuernos Mountains (*Baker*).

Weitere Fundorte sind bekannt von: Malakka (Perak) und Sumatra.

MICROTRACHELIZUS SIAMENSIS Kleine.

Microtrachelizus siamensis KLEINE, Journ. Fed. Malay Stat. Mus. 2 and 3, **13** (1926) 165, fig. 3.

SAMAR, Catbalogan (*Boettcher*).

Die Art lag mehrfach von der Malayischen Halbinsel vor, die Verbreitung dürfte sich mit der von *pubescens* decken.

MICROTRACHELIZUS TABACI Senna.

Microtrachelizus tabaci SENNA, Boll. Soc. Ent. Ital. **25** (1893) 323, t. 4, fig. 4.

MINDANAO, Provinz Zamboanga, Port Banga (*Boettcher*).

Weitverbreitete Art. Ich sah Belegstücke von: Burmah Malakka, Sumatra und Borneo. Der Autor nennt Neu-Guinea.

Die Gattung umfasst 27 Arten von denen 4 auf den Philippinen nachgewiesen sind. Die als Endemisme bezeichnete Art

ist wahrscheinlich auch noch auf den Sunda-Inseln zu finden. Die allgemeine Verbreitung ist folgende: 6 Arten sind æthiopisch und zeigen noch die Herkunft an, 15 sind rein orientalisch, 3 gehören dem austro-malayischen beziehungsweise dem australischen Gebiet an und 3 kommen in sehr grosser Migration über meherer Gebiete vor. Die æthiopischen Vertreter der Gattung sind in sich abgeschlossen sind aber habituel mit den anderer Regionen absolut übereinstimmend. Die philippinischen Arten sind nur Ausläufer des auf den Sunda-Inseln liegenden Massivs der orientalischen Arten und sind zoogeographisch ohne Belang. Von Bedeutung ist der Nachweis der Afrikaner. *Microtrachelizus* ist übrigens nicht die einzige Gattung die noch in Afrika Vertreter hat. Es sei nur auf *Araiorrhynchus* verwiesen, die allerdings die Philippinen nicht erreicht hat.

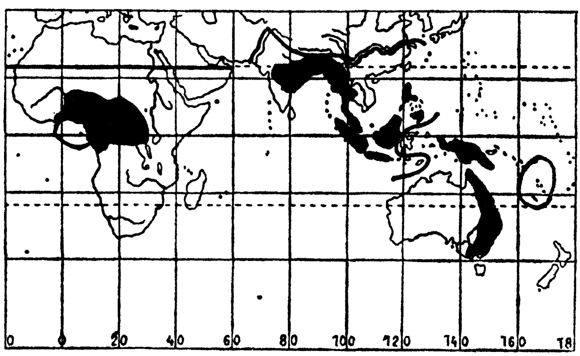

FIG. 10. Verbreitungskarte der Gattung *Microtrachelizus* Senna.

Genus HOPLOPISTHIUS Senna

Hoplopisthius SENNA, Ann. Mus. Genova (2) 12 (33) (1892) 451.

HOPLOPISTHIUS TRICHIMERUS Senna.

Hoplopisthius trichimerus SENNA, Ann. Mus. Genova (2) 12 (33) (1892) 451.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*). PALAWAN, Puerto Princesa (*Baker*).

Sehr verbreitete Art. Folgende Fundorte sind bekannt: Assam, Burmah, Malayische Halbinsel, Sumatra, Borneo, Java, Mentawei, Bali, Nias, Formosa.

Eine zweite Art ist von Celebes bekannt. Der Uebergang von den Sunda-Inseln über Palawan nach den Philippinen ist wichtig.

AMORPHOCEPHALINI

Genus CORDUS Schoenherr

Cordus SCHOENHERR, Mant. Insec. Curc. (1847) 10.

CORDUS PEGUANUS Senna.

Cordus peguanus SENNA, Ann. Mus. Genova (2) 12 (32) (1892) 463.

NEGROS, Cuernos Mountains (*Baker*). BASILAN (*Baker*).

Weitere Verbreitung: Burmah, Malakka, Sumatra.

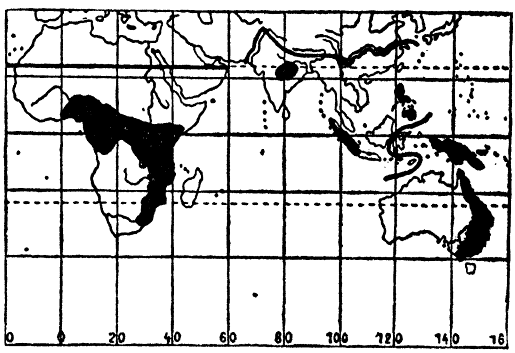

FIG. 11. Verbreitungskarte der Gattung *Cordus* Schoenh.

Die Gattung ist dadurch interessant, dass sie in sehr weiter Verbreitung vorkommt und dazwischen in grossen Gebieten wieder ganz fehlt. Zehn Arten sind æthiopisch, 2 orientalisch, 1 ist von Neu-Guinea bekannt und 7 sind Australier. Das schwache Auftreten im orientalischen Gebiet ist noch ganz ungeklärt. Das Areal von Malakka und den grossen Sunda-Inseln ist so intensiv durchforscht, dass längst ein *Cordus* bekannt geworden wäre, wenn einer vorhanden wäre. Andere Amorphocephalini sind doch mehrfach aufgefunden. Diese Gattung muss einen Weg genommen haben, der heute nicht nehr erkennbar und in den einzelnen Erdperioden verloren gegangen ist. Das sich auf den Philippinen nicht einmal eine eigene Art fand, ist merkwürdig, zeigt aber, dass einzelne Arten eine recht grosse Verbreitung haben können. Jedenfalls ist der *Cordus* von den Philippinen ein sehr interessanter Fall.

Genus LEPTAMORPHOCEPHALUS Kleine

Leptamorphocephalus KLEINE, Arch. Nat. A. 12, 82 (1916) (1918) 132.

LEPTAMORPHOCEPHALUS FŒDERATUS Kleine.

Leptamorphocephalus fœderatus KLEINE, Ent. Blätt. 19 (1923) 163.

NEGROS, Cuernos Mountains (*Baker*). Endemische Art.

Die 9 Arten umfassende Gattung ist rein orientalisch, mit ihrer Hauptstärke auf der Malayischen Halbinsel und Sumatra; *fœderatus* ist ein vorgeschobener Posten.

TABELLE 5.—*Verbreitungstabelle der Trachelizini.*

	Ceylon.	Indien.	Bengalen.	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Indo-China.	Formosa.	Japan.	Celebes.	Molukken.	Neu-Guinea.	Australien.	Polynesien.
Homophylus mindanensis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Metatrachelizus constants Kleine	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
Trachelizus bisulcatus Fabricius	+	+	+	+	+	+	+	+	+	+	—	—	—	—	—
Miolispa bicolor Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa clavicornis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa cruciata Senna	—	—	—	—	+	+	—	—	+	—	—	—	—	—	—
Miolispa discors Senna	—	—	—	+	—	+	—	—	+	—	+	—	—	—	—
Miolispa elongata Kleine	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Miolispa ephippium Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa flavolineata Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa flexilis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa formosa Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa fornicata Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa fraudatrix Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa intermedia Senna	—	—	—	—	—	+	+	—	—	—	+	+	—	—	—
Miolispa lineata Senna	—	—	—	+	—	—	+	—	—	—	—	—	—	—	—
Miolispa pascoei Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa paucicostata Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa persimilis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa pulchella Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miolispa robusta Kleine	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Miolispa siporana Senna	—	—	—	+	+	+	+	—	—	—	—	+	—	—	—
Miolispa unicolor Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hypomiolispa exarata Desbr.	—	—	—	—	+	+	+	—	—	—	—	—	—	—	—
Hypomiolispa helleri Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Hypomiolispa nupta Senna	—	—	+	+	+	+	+	—	—	—	—	—	—	—	—
Hypomiolispa ocularis Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hypomiolispa sponsa Kleine	—	—	—	+	+	+	+	—	—	—	—	—	—	—	—
Hypomiolispa tomentosa Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hypomiolispa trachelizoides Senna	—	—	—	+	+	+	+	—	—	—	—	+	—	—	—
Higonius cilo Lewis	—	+	+	—	—	—	—	—	+	+	—	—	—	—	—
Microtrachelizus flexus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Microtrachelizus pubescens Senna	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—
Microtrachelizus siamensis Kleine	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—
Microtrachelizus tabaci Senna	—	—	+	+	+	+	—	—	—	—	—	—	+	—	—
Hoplopisthius trichimerus Senna	—	+	+	+	+	+	—	+	—	—	—	—	—	—	—

[a] Endemisch.

Genus PARAMORPHOCEPHALUS Kleine

Paramorphocephalus KLEINE, Zool. Meded. Leid. 4, 5 (1920) 236.

PARAMORPHOCEPHALUS SETOSUS Kleine.

Paramorphocephalus setosus KLEINE, Philip. Journ. Sci. 28 (1925) 597, taf. 1, fig. 4.

SAMAR (*Baker.*) Endemische Art.

Die Amorphocephalini sind Myrmecophile, ihre Verbreitung ist also immer mehr oder weniger von der ihrer Wirtstiere abhängig. Letztere sind leider nur erst ganz wenig bekannt. Auf den Philippinen ist die Tribus sicher nur ganz schwach vertreten. Jahrelang haben mir überhaupt keine Vertreter vorgelegen, erst später konnte ich den Nachweis erbringen, dass sich auch auf diesen vorgeschobenen Posten myrmecophile Brenthiden finden. Es handelt sich in jedem Fall um Vorposten aus dem orientalischen Massiv, das sich um die Malayische Halbinsel und Sumatra konzentriert. Nach den Rändern des Gebietes lässt die Artstärke nach. Etwa die Hälfte aller Amorphocephalini leben in Afrika. Keine Tribus der ganzen Familie hat übrigens eine derartige West-Ost-Ausdehnung wie die Amorphocephalini: Bucht von Guinea bis Tahiti!

ARRHENODINI

Genus AGRIORRHYNCHUS Power

Agriorrhynchus POWER, Pet. Nouv. Ent. 2 (1878) 241.

AGRIORRHYNCHUS IGNARIUS Kleine.

Agriorrhynchus ignarius KLEINE, Philip. Journ. Sci. 28 (1925) 598, t. 1, figs. 5–7.

LUZON, Provinz Laguna, Los Baños (*Banks*). Endemische Art.

Vier Arten sind bekannt, alle sind Orientalen die westlich nicht über Burmah hinausgehen. Verbreitungszentrum sind die grossen Sunda-Inseln.

Genus EUPEITHES Senna

Eupeithes SENNA, Ann. Mus. Genova (2) 19 (39) (1898) 381.

EUPEITHES DOMINATOR Kleine.

Eupeithes dominator KLEINE, Ent. Blätt. 17 (1921) 125, fig. 4.

MINDANAO, Provinz Surigao, Surigao (*Baker*). SAMAR, Wright (*McGregor*). Endemische Art.

Vier Arten sind bekannt. Ueber die Verbreitung gilt das bei *Agriorrhynchus* Gesagte.

Genus PROPHTHALMUS Lacordaire

Prophthalmus LACORDAIRE, Gen. Col. 7 (1866) 427.

PROPHTHALMUS LONGIROSTRIS Gyllenhal.

Prophthalmus longirostris GYLLENHAL, Schoenh. Gen. Curc. 1 (1833) 323.

LUZON, Provinz Laguna, Mount Banahao (*Baker*).

Auf den Sunda-Inseln gemein, ferner von der Malayischen Halbinsel und Celebes bekannt. Es ist in der Gattung die Art mit grösster Migration.

PROPHTHALMUS TRICOLOR Power.

Prophthalmus tricolor POWER, Ann. Soc. Ent. Fr. (5) 8 (1878) 38.

LUZON, Provinz Camarines Sur, Mount Isarog (*Boettcher*); Provinz Laguna, Mount Maquiling (*Baker*), Mount Banahao, Los Baños, Paete (*Boettcher*): Provinz Ilocos Norte, Bangui (*Boettcher*): Provinz Pampanga, Arayat (*Boettcher*). CATANDUANES, Virac (*Boettcher*). MINDANAO, Provinz Surigao, Surigao (*Boettcher*): Provinz Lanao, Mumungan (*Boettcher*). SIARGAO, Dapa and Cabuntog (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*). SAMAR (*Baker*). LEYTE (*Boettcher*). SIBUYAN (*Baker*).

Die Art ist auf den Philippinen eine der häufigsten Brenthiden, die sicher auf allen Inseln zu finden ist. Die Art kommt ferner auf Celebes und auf den Molukken vor (Ceram, Buru, Amboina). Es haben sich Rassen gebildet, die aber keine geographischen Schlüsse zulassen.

Von den bekannten 17 Arten ist nur eine austromalayisch, alle anderen sind orientalisch.

Genus BARYRRHYNCHUS Lacordaire

Baryrrhynchus LACORDAIRE, Gen. Col. 7 (1866) 428.

BARYRRHYNCHUS SCHROEDERI Kleine.

Baryrrhynchus schroederi KLEINE, Stett. Ent. Zeit. (1914) 172.

LUZON, Provinz Laguna, Mount Maquiling, Los Baños (*Baker*); Mount Banahao (*Boettcher*): Subprovinz K a l i n g a, Balbalasan (*Boettcher*). MINDANAO, Provinz Agusan, Agusan (*Weber*): Provinz Surigao, Surigao (*Boettcher*): Provinz Lanao, Mumungan, Kolambugan (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*). SIBUYAN (*Baker*). SAMAR (*Baker*).

FIG. 12. Verbreitungskarte der Gattung *Baryrrhynchus* Lacord.

Baryrrhynchus schroederi ist eine der interessantesten Arten in der Gattung, denn sie hat eine Verbreitung wie keine andere. Ich sah sie auf folgender Linie: Siam-Philippinen-Celebes-Molukken-Neu-Guinea-Neu-Pommern. Sie umgeht also das orientalische Gebiet, denn der Vorstoss gegen Siam hat ganz bestimmut nicht über die Sunda-Inseln stattgefunden, sondern über Indo-China, wo die Art sehr wahrscheinlich noch aufgefunden wird. Sie ist auch in der Ausfärbung ganz appart. Von den 18 Arten sind 11 orientalisch, 7 gehören dem austro-malayischen beziehungsweise australischen Gebiet an. Die Orientalen haben keine Fühlung mit den östlichen Arten.

Genus EUPSALIS Lacordaire

Eupsalis LACORDAIRE, Gen. Col. 7 (1866) 430.

EUPSALIS KLEINEI K. M. Heller.

Eupsalis kleinei K. M. HELLER, Philip. Journ. Sci. 19 (1921) 624, t. 3, figs. 13, 14.

MINDANAO, Provinz Davao, Davao (im Museum Dresden, wahrscheinlich von Baker gesammelt). Endemische Art.

Die Gattung ist kein einheitlicher Typ. Die auf den Molukken, auf Neu-Guinea und Australien lebenden Arten sind der Untergattung *Schizœupsalis* zuzuweisen. Hierher gehört auch *kleinei* Heller. Die Beeinflussung durch östlicher Elemente ist ganz sicher, die beiden orientalischen Arten, von denen eine nur in Indien vorkommt, sind ohne Einfluss geblieben. Die Hauptmasse, 18 Arten, sind æthiopisch mit Ausstrahlung ins mediterrane Gebiet. Die orientalen gehören habituel noch dem afrikanischen Artmassiv an, die von den Philippine südlich und

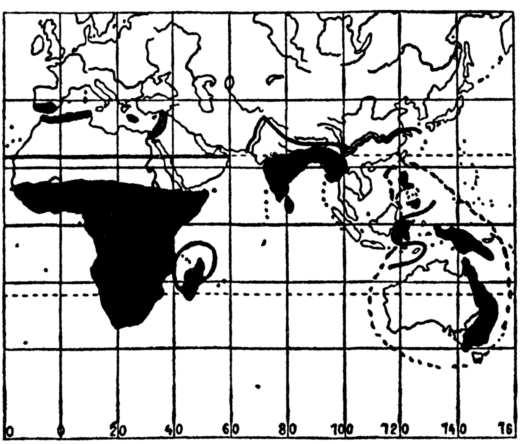

FIG. 13. Verbreitungskarte der Gattung *Eupsalis* Lacord.

südöstlich vorkommenden Arten bilden einen eigenen Verwandtschaftskreis. Sie sind am besten von *Eupsalis* zu trennen.

Genus CÆNORYCHODES Kleine

Cænorychodes KLEINE, Arch. Nat. A. 9, **86** (1920) 87.

CÆNORYCHODES SERRIROSTRIS Fabricius.

Cænorychodes serrirostris FABRICIUS, Syst. El. 2 (1801) 553.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*). MASBATE, Aroroy (*Boettcher*). MINDANAO, Provinz Agusan, Agusan River (*Weber*): Provinz Lanao, Iligan, Mumungan, Kolambugan, (*Boettcher*): Provinz Cotabato, Cotabato (*Taylor, Baker*). LEYTE (*Boettcher*). SIARGAO, Dapa (*Boettcher*). SAMAR (*Baker*). BASILAN (*Baker*).

Weitverbreitete gemeine Art, die sich durch ihr grosses Migrationsvermögen bis Celebes vorgeschoben hat. Verbreitungsgebiet: Malakka, Sumatra, Borneo, Java, Batu, Bali, Indo-China, Formosa, Obir.

CÆNORYCHODES SPLENDENS Kirsch.

Cænorychodes splendens KIRSCH., Mitt. Zool. Mus. Dres. **1** (1875) 50 nota.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*): Provinz Camarines Sur, Mount Isarog (*Boettcher*). MASBATE, Aroroy (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*). SIBUYAN (*Baker*). Endemische Art.

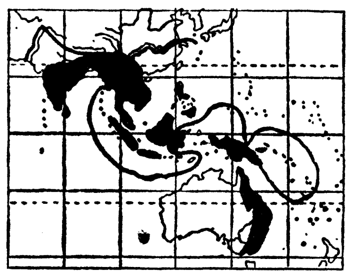

FIG. 14. Verbreitungskarte der Gattung *Caenorychodes* Kln.

Zwölf Arten sind bekannt, davon sind 6 orientalisch, 6 austromalayisch. Die Arten haben allgemein wenig Neigung zu Migration, nur *serrirostris* ist weiter verbreitet.

Genus PSEUDORYCHODES Senna

Pseudorychodes SENNA, Ann. Soc. Ent. Belg. **38** (1894) 375.

PSEUDORYCHODES PRÆCLARUS Kleine.

Pseudorychodes præclarus KLEINE, Philip. Journ. Sci. **28** (1925) 600, t. 1, fig. 8.

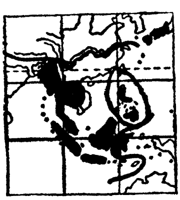

FIG. 15. Verbreitungskarte der Gattung *Pseudorychodes* Senna.

MINDANAO, Provinz Surigao (*Boettcher*). Endemische Art.

Von den 13 Arten sind 11 orientalisch, 1 ist von Celebes, 1 von Japan. Bei keiner Art ist grosse Migration erkennbar.

Genus AMPHICORDUS K. M. Heller

Amphicordus K. M. HELLER, Philip. Journ. Sci. § D 8 (1913) 151.

AMPHICORDUS IMPROPORTIONALIS K. M. Heller.

Amphicordus improportionalis K. M. HELLER, Philip. Journ. Sci. § D 8 (1913) 152, fig. 7.

MINDANAO ohne näheren Fundort (Museum Dresden); Provinz Lanao, Kolambugan (*Banks*). Nur diese eine, endemische, Art ist bekannt.

TABELLE 6.—*Verbreitungstabelle der Arrhenodini.*

	Indo-China.	Formosa.	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Celebes.	Molukken.	Neu-Guinea.
Agriorrhynchus ignarius Kleine [a]	—	—	—	—	—	—	—	—	—
Eupeithes dominator Kleine [a]	—	—	—	—	—	—	—	—	—
Prophthalmus longirostris Gyllenhal	—	—	+	+	+	+	+	—	—
Prophthalmus tricolor Power	—	—	—	—	—	—	+	+	—
Baryrrhynchus schroederi Kleine	+	—	+	—	—	—	+	+	+
Eupsalis kleinei Heller [a]	—	—	—	—	—	—	—	—	—
Cænorychodes serrirostris Fabricius	+	+	+	+	+	+	+	—	—
Cænorychodes splendens Kirsch [a]	—	—	—	—	—	—	—	—	—
Pseudorychodes præclarus Kleine [a]	—	—	—	—	—	—	—	—	—
Amphicordus improportionalis Heller [a]	—	—	—	—	—	—	—	—	—

[a] Endemisch.

Von den 195 bekannten Arrhenodini sind 90 orientalisch. Der Bestand auf den Philippinen mit nur 10 Arten ist also sehr gering. Schuld mag daran der Umstand mit sein, das in der Tribus so wenig Neigung zu Migration besteht.

BELOPHERINI

Genus YPSELOGONIA Kleine

Ypselogonia KLEINE, Philip. Journ. Sci. 20 (1922) 157.

YPSELOGONIA PEREGRINA Kleine.

Ypselogonia peregrina KLEINE, Philip. Journ. Sci. 20 (1922) 158, t. 1, fig. 1.

MINDANAO, Provinz Zamboanga, Dapitan (*Baker*). Endemische Art.

Eine zweite Art kommt in Formosa und Borneo vor.

Genus HETEROBLYSMIA Kleine

Heteroblysmia KLEINE, Ent. Blätt. **13** (1917) 285.

HETEROBLYSMIA ACCURATA Kleine.

Heteroblysmia accurata KLEINE, Arch. Nat. A. 3, **88** (1922) 215.

MINDANAO, Provinz Lanao, Kolambugan (*Boettcher*).

Die Art habe ich mehrfach von Borneo gesehen, wo sicher das Verbreitungszentrum liegt. Es wäre von Interesse festzustellen, ob sich *accurata* nicht auch auf Palawan findet.

HETEROBLYSMIA ELECTA Kleine.

Heteroblysmia electa KLEINE, Ent. Blätt. **19** (1923) 164, figs. 5, 6.

Näherer Fundort fehlt. Endemische Art.

HETEROBLYSMIA FORMIDOLOSA Kleine.

Heteroblysmia formidolosa KLEINE, Ent. Blätt. **19** (1923) 165, fig. 7.

NEGROS, Cuernos Mountains (*Baker*). Endemische Art.

Acht Arten sind bekannt, rein orientalisch und meist von den Sunda-Inseln.

Genus APOCEMUS Calabresi

Apocemus CALABRESI, Boll. Soc. Ent. Ital. **53** (1929) 58.

APOCEMUS IGNOBILIS Kleine.

Apocemus ignobilis KLEINE, Philip. Journ. Sci. **28** (1925) 602, t. 1, fig. 9.

LUZON, Provinz Bataan, Lamao (*Carpenter*). Endemische Art. Eine zweite Art ist von Malakka bekannt.

Genus HENARRHENODES K. M. Heller

Henarrhenodes K. M. HELLER, Philip. Journ. Sci. § D **8** (1913) 152.

HENARRHENODES MACGREGORI K. M. Heller.

Henarrhenodes macgregori K. M. HELLER, Philip. Journ. Sci. § D **8** (1913) 153, fig. 8.

LUZON, Subprovinz Benguet, Irisan River (*Baker*) : Provinz Nueva Vizcaya, Imugan (*Baker*) : Provinz Laguna, Mount Maquiling (*Baker*). MINDANAO, Provinz Lanao, Kolambugan (*Baker*). SIARGAO, Cabuntog (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*). POLILLO (Sammler unbekannt, wahrscheinlich *Baker*).

Es sind noch 2 orientalische Arten bekannt. Die philippinische Art ist dadurch ausgezeichnet, dass sie den Ausfärbungstyp der Neu-Guinea-Tiere hat.

Genus ECTOCEMUS Pascoe

Ectocemus PASCOE, Journ. Ent. 1 (1862) 388.

ECTOCEMUS BADENI Kirsch.

Ectocemus badeni KIRSCH, Ent. Mitt. Mus. Dresden 1 (1875) 48.

LUZON, Provinz Laguna, Mount Banahao (*Baker*). MINDANAO, Provinz Lanao, Kolambugan (*Banks*): Surigao (*Baker*).

Die Gattung umfasst 5 Arten, 3 sind orientalisch, 2 austromalayisch oder australisch.

Genus ANEPSIOTES Kleine

Anepsiotes KLEINE, Ent. Mitt. 10–12, 6 (1917) 318.

ANEPSIOTES LUZONICUS Calabresi.

Anepsiotes luzonicus CALABRESI, Boll. Soc. Ent. Ital. 51 (1919) 66, t. 2, fig. 3.

LUZON (Coll. *Senna*). Endemische Art.

ANEPSIOTES NITIDICOLLIS Calabresi.

Anepsiotes nitidicollis CALABRESI, Boll. Soc. Ent. Ital. 51 (1919) (1929) 69, t. 2, fig. 4.

MANILA (Coll. *Senna*). Endemische Art.

Die Gattung umfasst 7 orientalische Arten mit geringer Migration.

TABELLE 7.—*Verbreitungstabelle der Belopherini.*

	Borneo.	Celebes.
Ypselogonia peregrina Kleine [a]	—	—
Heteroblysmia accurata Kleine	+	—
Heteroblysmia electa Kleine [a]	—	—
Heteroblysmia formidolosa Kleine [a]	—	—
Apocemus ignobilis Kleine [a]	—	—
Ectocemus badeni Kirsch	—	+
Anepsiotes luzonicus Calabresi [a]	—	—
Anepsiotes nitidicollis Calabresi [a]	—	—

[a] Endemisch.

Die Belopherini sind von den bisher behandelten Tribus grundsätlich dadurch unterschieden, dass die nicht westlicher, sondern südöstlicher Provenienz sind. Die Tribus findet sich circumpolar auf der ganzen südlichen Hemisphäre mit Ausnahme von Afrika (wohl aber in Madagaskar). Der heute noch deut-

lich erkennbare Wanderzug der in die orientalische Region gekommen ist stammt aus dem Neu-Guinea-Massiv, auf das ich schon mehrfach hingewiesen habe. Von hieraus hat auch die Besiedelung der Philippinen stattgefunden, reine Typen Neu-Guineas finden sich und der Mangel jeder Anlehnung an die orientalische Region lassen das auch deutlich erkennen. Von 96 bekannten Arten sind 34 in die orientalische Region vorgedrungen und haben dort zum Teil ganz neue Formen gebildet.

ITHYSTENINI

Genus ACHRIONOTA Pascoe

Achrionota PASCOE, Ann. & Mag. Nat. Hist. (4) 10 (1872) 325.

ACHRIONOTA BILINEATA Pascoe.

Achrionota bilineata PASCOE, Ann. & Mag. Nat. Hist. (4) 10 (1872) 325, t. 15, fig. 4.

MINDANAO, Provinz Zamboanga, Dapitan (*Baker*).

Weiter haben mir folgende Fundorte vorgelegen: Malakka, Sumatra, Borneo.

ACHRIONOTA SPINIFER Kleine.

Achrionota spinifer KLEINE, Arch. Nat. A, 10, 87 (1921) 36, figs. 2, 3.

MINDANAO, Provinz Surigao, Surigao (*Baker*). SIARGAO, Dapa (*Boettcher*). LEYTE (*Boettcher*). PANAON (*Boettcher*). BOHOL, Bilar (*Ramos*). POLILLO (*McGregor*). Endemische Art. Eine dritte Art kommt endemisch auf Celebes vor.

Genus CEDIOCERA Pascoe

Cediocera PASCOE, Ann. & Mag. Nat. Hist. (5) 20 (1887) 20.

CEDIOCERA TRISTIS Senna.

Cediocera tristis SENNA, Not. Leyd. Mus. 14 (1892) 181.

NEGROS, Cuernos Mountains (*Baker*). BASILAN (*Baker*).

Die Gattung umfasst 2 Arten, die aber nicht sicher trennbar und die vielleicht nur Rassen einer Art sind. Es ist übrigens die einzige Gattung die einen mehr orientalischen Charakter hat. *Tristis* hat eine grosse Migration und kommt bis Neu-Guinea vor. Die ursprüngliche Herkunft ist also noch immer erkennbar. Mir lagen Belegstücke vor von: Malakka, Sumatra, Borneo, Java, Neu-Guinea.

Genus HETEROPLITES Lacordaire

Heteroplites LACORDAIRE, Gen. Col. 7 (1866) 471.

HETEROPLITES ERYTHRODERES Boheman.

Heteroplites erythroderes BOHEMAN, Schoenh. Gen. Curc. 5 (1840) 564.

LUZON, Provinz Ilocos Norte, Bangui (*Banks*) : Provinz Nueva Vizcaya, Imugan (*Boettcher*) : Provinz Laguna, Mount Banahao (*Boettcher*) : Provinz Camarines Sur, Mount Isarog, Balagbag (*Boettcher*). MINDANAO, Provinz Surigao, Surigao (*Boettcher*) : Provinz Bukidnon, Tangkulan (*Boettcher*). Ballalon (?) (*Boettcher*). Endemische Art. Färbung des Neu-Guinea Typs. Eine zweite Art lebt auf Celebes mit Ausstrahlung nach Borneo.

Genus DIURUS Pascoe

Diurus PASCOE, Journ. Ent. 1 (1862) 392.

DIURUS FURCILLATUS Gyllenhal.

Diurus furcillatus GYLLENHAL, Schoenh. Gen. Curc. 1 (1833) 359.

MINDANAO, Provinz Surigao, Surigao (*Baker*) : Provinz Davao, Davao (*Weber*). MINDORO, Baco River (*McGregor*). LUZON, Ilocos Norte, Bangui (*Banks*). SAMAR (*Baker*).

Die gemeinste Art mit grösster Migration, Malakka, Sumatra, Borneo, Java. Ueberall gleich häufig.

DIURUS PHILIPPINICUS Senna.

Diurus philippinicus SENNA, Boll. Soc. Ent. Ital. 41 (1909) 45.

Endemische Art, näherer Fundort nicht angegeben.

DIURUS SAMARENSIS Kleine.

Diurus samarensis KLEINE, Stett. Ent. Zeit. 87 (1926) 370, fig. 16.

SAMAR (*Baker*). Endemische Art.

DIURUS SHELFORDI Senna.

Diurus shelfordi SENNA, Proc. Zool. Soc. Lond. (1902) 279, t. 20, fig. 6 ♀.

MINDANAO, Provinz Lanao, Kolambugan (*Baker*). BASILAN (*Baker*). Ausserdem von Borneo bekannt.

Diurus umfasst 25 Arten die mit geringen Ausnahmen orientalisch sind. In Neu-Guinea ist eine Art sicher nachgewiesen. Auch auf den Carolinen soll eine vorkommen, es hat sie ausser dem Autor wohl niemand gesehen. Diese Art bleibt unklar. Auffällig ist das gänzliche Fehlen auf den Molukken, so dass vorläufig noch kein Anschluss der Orientalen an die Neu-Guinea-

Art möglich war. Vielleicht ist die Zuwanderung über die kleinen Sunda-Inseln erfolgt und die Molukken sind tatsächlich unberührt geblieben.

Was bei den Belopherini über Herkunft und gegenwärtige Verteilung der Arten gesagt ist, tifft auch hier zu. Ja es ist die Beteiligung des Ausgangszentrums. Neu-Guinea Molukken mit den ostlichen Inselschwärmen und Australien noch deutlicher als bei den Belopherini. Von den 112 Arten sind 51 austro-malayisch oder australisch, 30 gehören der orientalischen, 22 der neotropischen Region an. Zu den Austromalayen dürfte eine Art mit Ausstrahlung in die orientalische Region zu rechnen sein, von einer ist der Fundort nicht sicher.

Mehrfach finden sich unter den wenigen Arten solche mit Neu-Guinea-Färbung, also ganz analog den Verhältnissen bei den Belopherini.

TABELLE 8.—*Verbreitungstabelle der Ithystenini.*

	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Neu-Guinea.
Achrionota bilineata Pascoe	+	+	+	—	—
Achrionota spinifer Kleine [a]	—	—	—	—	—
Cediocera tristis Senna	+	+	+	+	+
Heteroplites erythroderes Boheman [a]	—	—	—	—	—
Diurus furcillatus Gyllenhal	+	+	+	+	—
Diurus philippinicus Senna [a]	—	—	—	—	—
Diurus samarensis Kleine [a]	—	—	—	—	—
Diurus shelfordi Senna	—	—	+	—	—

[a] Endemisch.

PSEUDOCEOCEPHALINI

Genus OPISTHENOPLUS Kleine

Opisthenoplus KLEINE, Deut. Ent. Zeit. 1 (1922) 139.

OPISTHENOPLUS CALABRESII Kleine.

Opisthenoplus calabresii KLEINE, Arch. Nat. A. 10, 87 (1921) 35.

LUZON, Subprovinz Kalinga, Balbalasan (*Boettcher*), mehrfach ohne näheren Fundort gesehen. Endemische Art mit Ausfärbung des Neu-Guinea Typs.

OPISTHENOPLUS CAVUS F. Walker.

Opisthenoplus cavus F. WALKER, Ann. & Mag. Nat. Hist. (3) 3 (1859) 262.

LUZON, Provinz Laguna, Mount Banahao (*Boettcher*) : Provinz Nueva Vizcaya, Imugan (*Boettcher*). MINDANAO, Provinz Su-

rigao, Surigao (*Boettcher*); Provinz Lanao, Mumungan (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*).

Häufige, weitverbreitete Art die in der ganzen orientalischen Region vorkommt. Ich sah Belegstücke von: Ceylon, Indien, Burmah, Andamanen, Indo-China, Malakka, Sumatra, Borneo. Hauptgebiet ist Indien. Von Java sah ich die Art noch nicht.

OPISTHENOPLUS FASCINATUS Kleine.

Opisthenoplus fascinatus KLEINE, Deut. Ent. Zeit. 1 (1922) 140, figs. 7, 8.

LUZON, Provinz Laguna, Mount Banahao (*Baker*).

Die Verbreitung der Art ist wohl nur erst zum Teil bekannt. Mir lagen belegstücke vor von: Sumatra, Indien, Formosa. Das Verbreitungszentrum lässt sich zur Zeit nicht angeben.

OPISTHENOPLUS FECUNDUS Kleine.

Opisthenoplus fecundus KLEINE, Ent. Blätt. 19 (1923) 165.

NEGROS, Cuernos Mountains (*Baker*). Endemische Art.

OPISTHENOPLUS MADENS Lacordaire.

Opisthenoplus madens LACORDAIRE, Gen. Col. 7 (1866) 455, nota 2.

SIBUYAN (Sammler unbekannt).

Die Verbreitung von *madens* hat einige Aehnlichkeit mit der von *cavus*. Das eigentliche Zentrum muss aber mehr östlich liegen, da mir noch niemals ein Belegstück aus Indien vorgelegen hat. Ich sah die Art von: Malakka, Andamanen, Indo-China, Sumatra und Java. Die Ausbreitung nach Südosten ist also auch grösser als bei *cavus*.

Die 9 bekannten Arten sind orientalisch.

Genus HORMOCERUS Schoenherr

Hormocerus SCHOENHERR, Curc. Disp. (1826) 70.

HORMOCERUS RETICULATUS Fabricius.

Hormocerus reticulatus FABRICIUS, Syst. El. 2 (1801) 552.

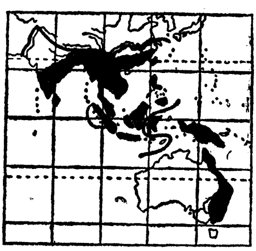

FIG. 16. Verbreitungskarte der Gattung *Hormocerus* Schoenh.

Diese gemeine, von Ceylon bis Ost-Australien überall vorkommende Art hat zahlreiche Rassen gebildet, die meist ineinander übergehen. Die von Boheman als *scrobicollis* beschriebene Art kommt auf den Philippinen vor und man findet in älteren Sammlungen häufig zahlreiche Belegstücke. Baker und Boettcher haben die Art nicht gefunden. Es ist doch merkwürdig, dass diese ausgezeichneten Sammler das Tier nicht gefunden haben.

Genus APTERORRHINUS Senna

Apterorrhinus SENNA, Not. Leyd. Mus. 17 (1895) 59.

APTERORRHINUS COMPRESSITARSIS Senna.

Apterorrhinus compressitarsis SENNA, Not. Leyd. Mus. 17 (1895) 61.

LUZON, Provinz Ilocos Norte, Bangui (*Boettcher*). SIARGAO, Dapa (*Boettcher*). LEYTE (*Boettcher*).

Sehr weitverbreitete, aber nicht häufige Art. Ich sah Tiere von: Malakka, Sumatra, Java, Buru.

APTERORRHINUS ALBATUS Kleine.

Apterorrhinus albatus KLEINE, Arch. Nat. A. 3, 87 (1921) 226.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*).

Auch hier ist die Verbreitung noch ganz unübersichtlich. Mir lagen Belegstücke von Neu-Guinea und Queensland vor.

Genus SCHIZOTRACHELUS Lacordaire

Schizotrachelus LACORDAIRE, Gen. Col. 7 (1866) 454.

SCHIZOTRACHELUS ANGULATICEPS Senna.

Schizotrachelus angulaticeps SENNA, Boll. Soc. Ent. Ital. 31 (1899) 308.

LUZON, Subprovinz Kalinga, Balbalasan (*Boettcher*) : Provinz Nueva Vizcaya, Imugan (*Boettcher*) : Provinz Ilocos Norte, Bangui (*Boettcher*). NEGROS, Cuernos Mountains (*Baker*). LEYTE, Burauen (*Boettcher*). SAN MIGUEL (*Boettcher*). BASILAN (*Baker*).

Weitere Funde sind bekannt von: Malayische Halbinsel, Borneo, Celebes. Die Funde sind noch zu sporadisch und geben keinen Ueberblick über die Verbreitung.

SCHIZOTRACHELUS BAKERI Kleine.

Schizotrachelus bakeri KLEINE, Arch. Nat. A. 10, 87 (1921) 33.

(*a*) Nominatform.

LUZON, Provinz Laguna, Los Baños (Sammler unbekannt) : Mount Banahao (*Boettcher*) : Subprovinz Benguet, Baguio (*Baker*). CATANDUANES, Virac (*Boettcher*). NEGROS, Oriental Negros, Cuernos Mountains (*Baker*) : Occidental Negros, Fabrica (*Schultze*). SIBUYAN (*Baker*). POLILLO (*Baker*).

(*b*) Forma *concolor*.

LUZON, Provinz Laguna, Mount Banahao, Los Baños (*Baker*) : Provinz Nueva Vizcaya, Imugan (*Boettcher*). MINDANAO, Surigao, Surigao (*Baker*) : Provinz Lanao, Kolambugan, Iligan (*Baker*). SIARGAO, Cabuntog (*Boettcher*). NEGROS (*Baker*).

SAMAR (*Baker*). BASILAN (*Boettcher*). Endemische, aber wie es scheint, auf allen Inseln vorkommende Art.

SCHIZOTRACHELUS BREVICAUDATUS Lacordaire.

Schizotrachelus brevicaudatus LACORDAIRE, Gen. Col. 7 (1866) 455, nota 2.

LUZON, Provinz Laguna, Los Baños (Sammler unbekannt). NEGROS, Cuernos Mountains (*Baker*). SIBUYAN (*Baker*).

Auf den grossen Sunda-Inseln ebenso häufig wie auf den Philippinen.

SCHIZOTRACHELUS BRUNNEUS Kleine.

Schizotrachelus brunneus KLEINE, Arch. Nat. A. 10, 87 (1921) 36.

LUZON, Provinz Laguna, Los Baños (Sammler unbekannt): Provinz Tayabas, Malinao (*Baker*).

SCHIZOTRACHELUS CONSIMILIS Kleine.

Schizotrachelus consimilis KLEINE, Ent. Blätt. 19 (1923) 166.

LUZON, Provinz Laguna, Los Baños; Manila (Sammler unbekannt). Ich sah die Art auch noch von Amboina.

SCHIZOTRACHELUS CORPULENTUS Kleine.

Schizotrachelus corpulentus KLEINE, Arch. Nat. A. 10, 87 (1921) 32.

MINDANAO, Provinz Agusan, Butuan (*Baker*). Endemische Art.

SCHIZOTRACHELUS IMBRICELLUS Kleine.

Schizotrachelus imbricellus KLEINE, Philip. Journ. Sci. 28 (1925) 604.

LUZON, Provinz Laguna, Mount Banahao (*Baker*). Endemische Art.

SCHIZOTRACHELUS IMITATOR Kleine.

Schizotrachelus imitator KLEINE, Philip. Journ. Sci. 28 (1925) 603, t. 1, fig. 10, 11.

LUZON, Subprovinz Kalinga, Balbalasan (*Boettcher*). LEYTE, Burauen, San Miguel (*Boettcher*). PANAON (*Boettcher*). CAMIGUIN (*Boettcher*). CATANDUANES, Virac (*Boettcher*). Endemische Art.

SCHIZOTRACHELUS INCONSTANS Kleine.

Schizotrachelus inconstans KLEINE, Arch. Nat. A. 10, 87 (1921) 31.

LUZON, Provinz Laguna, Mount Maquiling (*Baker*).

Von den 31 Arten sind nur 8 nicht in der orientalischen Region. Von den 8 Nicht-Orientalen sind 6 auf den Molukken, (einschliesslich Celebes) und nur 2 erreichen Neu-Guinea oder

Australien. Der Habitus der Gattung ist einheitlich, nur in der Figur des Kopfes lassen sich zwei Gruppen erkennen. Diese sind aber nicht zoogeographisch geschieden.

Von den 121 zur Tribus gehörenden Arten sind 33 der æthiopischen, 23 der madegassischen und 43 der orientalischen Region zuzuzählen, 22 sind austro-malayisch bezeihungsweise australisch und 1 kommt von Ceylon bis Ost-Australien vor. Die Pseudoceocephalini gehören also nicht dem Verbreitungskreis der Belopherini und Ithystenini. Sie haben ihren Ursprung in Afrika. Die Tribus hat einen intermediären Charakter, die, wahrscheinlich aus den Trachelizini oder mit diesen aus einer noch tieferen Wurzel entstanden, auch als Ausgangspunkt der Nemocephalini anzusehen ist. Aus diesen haben sich die Brenthini entwickelt, vielleicht sind auch die Taphroderini und Ulocerini näher verwandt als man annimmt. Jedenfalls ist der Einfluss auf die Brenthiden der neotropischen Region sehr gross. Nach Osten hin ist der Einfluss geringer gewesen. Man vergleiche hierzu meine Arbeit: "Die geographische Verbreitung der Brenthidæ." [a]

Gesamt 267 Gattungen mit 1260 Arten. Davon sind im Gebiet: Gesamt 48 Gattungen mit 124 Arten gefunden. Das sind rund 18 Prozent der Gattungen und 9.9 Prozent der Arten. Für ein so kleines Verbreitungsgebiet eine stattliche Anzahl. Von den Gattungen haben nur *Miolispa* und *Schizotrachelus* einen grösseren Artbestand aufzuweisen. Sieben Tribus kommen überhaupt nicht im Gebiet vor, sie sind mit Ausnahme von Eutrachelini auch nicht in der orientalischen, austromalayischen und australischen Region vertreten.

Bestimmungstabelle der philippinischen Brenthiden.

A. TRIBUS

1. Rüssel in beiden Geschlechtern von gleicher Gestalt.......... 2.
   Prorostrum des ♂ von verschiedener Gestalt, aber niemals fadenförmig, des ♀ immer lang, mehrfach so lang wie das Metarostrum, fadenförmig, zum Bohren eingerichtet.......... 4.
2. Prothorax am Halse verengt, zum Einlegen der Voderbeine eingerichtet, Elytren am Hinterrand an der Sutura zugespitzt.... Calodromini.
   Prothorax nicht verengt, Elytren nicht zugepitzt.......... 3.
3. Tibien der Vorderbeine mit grossem Innenzahn.......... Stereodermini.
   Tibien ohne Innenzahn .... Trachelizini.
4. Kopf und Rüssel, oder wenigstens der letztere, deformiert. Amorphocephalini.
   Nicht deformiert .... 5.

[a] Arch. Nat. A. 10, 87 (1921) 38–132.

TABELLE 9.—*Verbreitungstabelle der Pseudoceocephalini.*

	Ceylon.	Indien.	Bengalen.	Andamanen.	Indo-China.	Malay-Halbinsel.	Sumatra.	Borneo.	Java.	Formosa.	Molukken.	Neu-Guinea.	Australien.
Opisthenoplus calabresii Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Opisthenoplus cavus F. Walker	+	+	+	+	+	+	+	+	+	—	—	—	—
Opisthenoplus fascinatus Kleine	—	+	—	—	—	—	+	—	—	+	—	—	—
Opisthenoplus fecundus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Opisthenoplus madens Lacordaire	—	—	—	+	+	+	+	—	+	—	—	—	—
Hormocerus reticulatus Fabricius	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Apterorrhinus compressitarsis Senna	—	—	—	—	—	+	+	—	+	—	+	—	—
Apterorrhinus albatus Kleine	—	—	—	—	—	—	—	—	—	—	—	+	+
Schizotrachelus angulaticeps Senna	—	—	—	—	—	+	—	+	—	—	+	—	—
Schizotrachelus bakeri Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus brevicaudatus Lacordaire	—	—	—	—	—	—	+	+	+	—	—	—	—
Schizotrachelus brunneus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus consimilis Kleine	—	—	—	—	—	—	—	—	—	—	+	—	—
Schizotrachelus corpulentus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus imbricellus Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus imitator Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—
Schizotrachelus inconstans Kleine [a]	—	—	—	—	—	—	—	—	—	—	—	—	—

[a] Endemisch. [b] Von Australien bis Ceylon gemein.

5. Fühler vor der Mitte des Rüssels eingefügt, Metatarsus auffallend verlängert .... Ithystenini.
   Fühler in der Mitte des Rüssels stehend, Metatarsus nicht auffallend verlängert .... 6.
6. Fühler und Beine lang, Habitus schlank .... Belopherini.
   Fühler und Beine kurz, Habitus gedrungen........ 7.
7. Mandibeln das Mannes gross, Rüssel gedrungen........ Arrhenodini.
   Mandibeln das Mannes klein, Rüssel schlank, mehr oder weniger walzig. Pseudoceocephalini.

B. GATTUNGEN

1. CALODROMINI

1. Tarsen hypermorph, Metatarsus fast so lang wie das ganze Tier. *Calodromus* Guérin.
   Tarsen im Verhältnis zum Körper und den Beinen normal, höchstens der Metatarsus so lang wie das 2. und 3. Glied zusammen........ 2.

TABELLE 10.—*Stärkenverhältnis der philippinischen Gattungen und Arten zu den Brenthiden der ganzen Welt.*

	Der ganzen Welt.		Davon im Gebiet.	
	Gattungen.	Arten.	Gattungen.	Arten.
Calodromini	62	181	11	26
Stereodermini	8	89	3	15
Trachelizini	27	225	9	36
Amorphocephalini	17	83	3	3
Arrhenodini	41	196	8	10
Belopherini	24	95	6	9
Eutrachelini	1	1	0	0
Tychaeini	1	1	0	0
Ithystenini	21	108	4	8
Ulocerini	2	22	0	0
Pseudoceocephalini	39	124	4	17
Taphroderini	8	32	0	0
Rhyticephalini	1	2	0	0
Nemocephalini	12	62	0	0
Brenthini	3	36	0	0

2. Hinterschienen hypermorph oder doch von auffallender Gestalt, niemals normal .... 3.
   Hinterschienen normal .... 4.
3. Auf den Elytren sind alle Rippen gleichmässig entwickelt. *Cyphagogus* Parry.
   Zweite Rippe verkürzt .... *Epigogus* Kleine.
4. Fühler nach vorn in grossen Gruben stehend, die durch einer mehr oder weniger schmale Wand getrennt sind .... 5.
   Fühler seitlich stehend, in Rüsselbreite getrennt .... 6.
5. Auf den Elytren ist die 2. Rippe weit unterbrochen. *Orthopareia* Kleine.
   Die 3., 5. und 7. Rippen vekürzt .... *Asaphepterum* Kleine.
6. Prothorax vorn gar nicht oder nur ganz wenig verengt .... 7.
   Prothorax vorn immer zum Einlegen der Beine verengt .... 9.
7. Unterseite des Kopfes oder Rüssels ohne Zahn oder buckliger Verdickung auf den Seitenkanten .... *Opisthenoxys* Kleine.
   Unterseite mit mehr oder weniger grossem Zahn oder buckliger Verdickung auf Kopf oder Metarostrum .... 8.
8. Körper schuppenartig breit behaart .... *Pseudocyphagogus* Desbr.
   Körper nicht schuppenartig behaart .... *Mesoderes* Senna.
9. Kopf unterseits nicht gezahnt .... *Atopomorphus* Kleine.
   Kopf unterseits gezahnt .... 10.
10. Auf den Elytren sind die 1. und 3. Rippen an der Basis verkürzt, von der 2. und 4. eingeschlossen .... *Dictyotopterus* Kleine.
    Alle Rippen normal lang .... *Eterozemus* Senna.

2. STEREODERMINI

1. Fühler sehr lang und dünn, zuweilen von Körperlänge. *Jonthocerus* Lacordaire.
   Fühler kurz, gedrungen .... 2.
2. Neunte bis elfte Fühlerglied verdickt, erheblich grösser als die vorhergehenden .... *Stereodermus* Lacordaire.
   Neunte bis elfte Fühlerglied nicht verdickt, zuweilen kaum so lang wie die vorhergehenden .... *Cerobates* Schoenherr.

3. TRACHELIZINI

1. Elytren mit erhabenen und tiefliegenden Rippen, Hinterrand an der Sutura verlängert .... *Hoplopisthius* Senna.
   Elytren mit gleichhohen Rippen, Hinterrand gerundet.......... 2.
2. Prothorax ungefurcht .... 3.
   Prothorax gefurcht .... 4.
3. Auf den Elytren sind alle Rippen ausgebildet.... *Miolispa* Pascoe (pars).
   Nur die Sutura ist voll entwickelt, die folgenden Rippen fehlen ganz oder sind rudimentär .... *Homophylus* Kleine.
4. Vorderschienen innenseits keilförmig erweitert *Metatrachelizus* Kleine.
   Vorderschienen nicht erweitert .... 5.
5. Ausser der Sutura sind nur noch eine bis zwei Rippen vorhanden. *Trachelizus* Schoenherr.
   Alle Rippen sind entwickelt .... 6.
6. Kopf oberseits und an den Seiten mehrfach eingekerbt, oder tuberkelartig verdickt .... 7.
   Kopf nicht eingekerbt, glatt gerundet.......... *Microtrachelizus* Senna.
7. Kopf länger als breit, Augen nach vorn gerückt........ *Miolispa* Pascoe.
   Kopf kurz, Augen immer an der Basis stehend.......... 8.
8. Grössere Arten, 10 bis 15 mm., Schenkel wehrlos *Hypomiolispa* Kleine.
   Kleine Arten, 5 bis 8 mm., vor der Schenkel gedornt........ *Higonius* Lewis.

4. AMORPHOCEPHALINI

1. Kopf rundlich, nur der Rüssel deformiert.......... *Cordus* Schoenherr.
   Kopf und Rüssel deformiert.......... 2.
2. Prorostrum schmaler als das Metarostrum, unterseits glatt, nicht gerinnt .... *Leptamorphocephalus* Kleine.
   Prorostrum breiter als das Metarostrum, unterseits mehr oder weniger vorgezogen oder verdickt .... *Paramorphocephalus* Kleine.

5. ARRHENODINI

1. Rüssel so breit wie der Kopf oder kaum schmaler, robust, Mandibeln immer kräftig, einen freien Raum einschliessend oder nicht.......... 2.
   Rüssel schmaler als der Kopf, nach dem Vorderrand erweitert, mit grossen, vorstehenden Mandibeln die einen grossen, freien Raum einschliessen .... *Eupsalis* Lacordaire.
   Rüssel von ähnlicher Gestalt, Mandibeln klein.......... 5.
   Rüssel am Vorderrand nicht erweitert, mehr oder weniger parallel, Mandibeln klein bis sehr klein.......... *Amphicordus* Heller.

2. Prorostrum sehr breit, mehr oder weniger parallel, Vorderrand tief eingeschnitten und die Mandibeln im Einschnitt verborgen. *Agriorrhynchus* Power.
   Prorostrum gegen den Vorderrand nur gerung verbreitert, Mandibeln nicht in einer Einbuchtung des Vorderrandes verborgen, sondern vorstehend .... 3.
3. Rüssel dick, walzig, im Verhältnis zum Kopf sehr lang. *Eupeithes* Senna.
   Rüssel nicht walzig, normal lang .... 4.
4. Mandibeln gross, zangenartig, einen freien Raum einschliessend, Kopf meist sehr lang, Augen klein, nach vorn gerückt. *Prophthalmus* Lacordaire.
   Mandibeln nicht gross, nicht zangenartig, nur einen kleinen, freien Raum einschliessend .... *Baryrrhynchus* Lacordaire.
5. Kopf hinter den Augen seitlich gedornt oder über den Hals nach hinten vorgezogen .... *Cænorychodes* Kleine.
   Kopf nicht gedornt oder über den Hals erweitert *Pseudorychodes* Senna.

6. BELOPHERINI

1. Prorostrum am Vorderrand gar nicht oder nur gering verbreitert, jedenfalls nicht nach den Seiten ausladend .... 2.
   Prorostrum am Vorderrand nach den Seiten spitz verbreitert .... 3.
2. Schenkel ungedornt .... *Ypselogonia* Kleine.
   Schenkel gedornt .... *Heteroblysmia* Kleine.
3. Metarostrum mit starkem Seitenzahn .... *Apocemus* Calabresi.
   Ohne Seitenzahn .... 4.
4. Mandibeln sehr gross, einen freien Raum einschliessend. *Henarrhenodes* Heller.
   Mandibeln klein, keinen freien Raum einschliessend. *Anepsiotes* Kleine.

7. ITHYSTENINI

1. Elytren glatt, ausser der Sutura höchstens noch eine Rippe vorhanden, die folgenden nur punktstreifig .... 2.
   Elytren regelmässig punktstreifig, neben der Sutura keine scharfen Rippen .... 3.
2. Erste und zweite Abdominalsegment deutlich gefurcht. *Cediocera* Pascoe.
   Abdomen nicht gefurcht, höchstens schwach abgeplattet. *Achrionota* Pascoe.
3. Ohne kleiige Beschuppung, Prothorax gefurcht *Heteroplites* Lacordaire.
   Mit kleiiger Beschuppung, Prothorax ungefurcht .... *Diurus* Pascoe.

8. PSEUDOCEOCEPHALINI

1. Elytren am Hinterrand mehr oder weniger verlängert. *Opisthenoplus* Kleine.
   Elytren nicht verlängert .... 2.
2. Elytren an der Basis ungezahnt .... *Schizotrachelus* Lacordaire.
   Elytren an der Basis gezahnt .... 3.
3. Klauenglied wenn auch kräftig, so doch keulig *Hormocerus* Schoenherr.
   Klauenglied walzig, seitlich zusammengepresst .... *Apterorrhinus* Senna.

C. ARTEN

1. CALODROMINI

Genus CALODROMUS Guérin

Metatarsus mit einem Zahn .... *C. mellyi* Guérin.
Mit zwei Zähnen .... *C. crinitus* Kleine.

Genus CYPHAGOGUS Parry

1. Elytren mit 2 rotgelben Binden auf jeder Seite.
C. modiglianii Senna.
Elytren einfarbig, schwarz .... 2.
2. Pro- und Mesorostrum und eine kielförmige Platte auf dem Metarostrum glänzend; Kopf und Rüssel sonst matt .... 3.
Kopf und Rüssel gleichmässig glatt .... 4.
3. Der glänzende Teil des Rüssels zart punktiert; 1. und 2. Abdominalsegment nicht gefurcht .... *C. planifrons* Kirsch.
Der glänzende Teil an der Basis grob, rugos punktiert; 1. und 2. Abdominalsegment keilförmig, kraftig gefurcht.... *C. gladiator* Kleine.
4. Kopf über den Augen mit groben, zuweilen zu einer Furche verschmolzenen Punkten; Kopf grob, einzeln punktiert, in den Punkten behaart .... 5.
Kopf ohne Augenfurche, unbehaart, selten mit einzelnen Härchen am Hinterkopf .... 6.
5. Unterseite des Kopfes mit mehreren Querwülsten.
C. longulus Senna.
Ohne Querwülste .... *C. silvanus* Senna.
6. Metatarsus der Hinterbeine ohne Stiel kürzer als die 2. und 3. Glieder zusammen .... 7.
Metatarsus länger als die 2. und 3. zusammen .... 8.
7. Schlanke Art, Thoracalconus bucklig, Stiel der Hinterschenkel an der Keule unterseits tief, fast halbkreisförmig eingekerbt.
C. westwoodi Parry.
Gedrungene Art, Thoracalconus rechwinklig, gerade aufsteigend, Stiel der Hinterschenkel an der Keule nicht eingekerbt.
C. buccatus Kleine.
8. Stiel der Hinterschenkel gerade, am Uebergang zur Keule nicht verengt oder auf Ober- und Unterseite eingekerbt .... 9.
Stiel der Hinterschenkel an der Keule verengt oder eingekerbt........ 10.
9. Rüssel schmal, viel länger als der Kopf........ *C. tabacicola* Senna.
Rüssel nicht auffalend verschmälert, so lang oder kürzer als der Kopf.
C. simulator Senna.
10. Untere Hälfte der Fühler; Wurzel der Schenkel und die drei letzten Abdominalsegmente rötlich .... *C. eichhorni* Kirsch.
Einfarbig schwarz .... *C. whitei* Westwood.

Genus EPIGOGUS Kleine

Nur eine Art .... *E. flexibilis* Kleine.

Genus ORTHOPAREIA Kleine

Nur eine Art .... *O. idonea* Kleine.

Genus ASAPHEPTERUM Kleine

Nur eine Art .... *A. formosanum* Kleine.

Genus OPISTHENOXYS Kleine

Fühlerglied am längsten, alle Glieder länger als breit.
O. ochraceus Kleine.
Fühlerglied am längsten, die folgenden Glieder perlig.
O. boettcheri Kleine.

Genus PSEUDOCYPHAGOGUS Desbr.

Nur eine Art .... *P. squamifer* Desbr.

Genus MESODERES Senna.

Nur eine Art .... *M. fessus* Kleine.

Genus ATOPOMORPHUS Kleine

Nur eine Art .... *A. schultzei* Kleine.

Genus ETEROZEMUS Senna

Elytren rotbraun, Querbinde schwarz.............. *E. pubens* Senna.
Elytren schwarz mit 4 braunen Makeln.............. *E. lætus* Senna.

Genus DICTYOTOPTERUS Kleine

Zweifarbige Art; Prothorax, Kopf und Rüssel ziegelrot; Elytren blauschwarz; Prothorax unbehaart.............. *D. pulcherrimus* Kleine.
Einfarbige Art; Prothorax, namentlich an den Seiten, zottig behaart.
D. philippinensis Kleine.

2. STEREODERMINI

Genus JONTHOCERUS Lacordaire

1. Zweite Rippe der Elytren in der Mitte nicht unterbrochen.
J. laticostatis Kleine.
Zweite Rippe mehr oder weniger, meist beträchtlich unterbrochen.... 2.
2. Prothorax ungefurcht, rot gefärbt; Elytren von tiefschwarzer Farbe.
J. bicolor Heller.
Prothorax kräftig gefurcht oder an der Basis tief grubig eingedrückt, das ganze Tier einfarbig.............................. 3.
3. Kopf hinter den Augen bestimmt winklig.......... *J. modiglianii* Senna.
Kopf hinter den Augen gerundet.............. *J. asiaticus* Kleine.

Genus STEREODERMUS Lacordaire

Nur eine Art .... *S. flavotibialis* Kleine.

Genus CEROBATES Schoenherr

1. Aussenecken der Elytren am Absturz kurz gezahnt.
C. clinatus Kleine.
Aussenecken gerundet .... 2.
2. Prothorax ungefurcht .... 3.
Prothorax gefurcht .... 7.

3. Elytren von der Sutura bis zum Absturz dreifurchig, an den Seiten leicht gestreift oder schwach punktiert; 3. Furche bis zum Absturz verlängert, zuweilen in der Mitte obsolet seltener verschwommen und unsicher .... 4.
   Elytren nur an der Basis dreifurchig, an den Seiten glatt oder leicht gestreift, 3. Furche immer gegen den Absturz verschwindend........ 6.
4. Elytren gegen den Absturz lang, auffällig verschmälert. *C. angustipennis* Senna.
   Elytren im Apicalteil normal verschmälert........ 5.
5. Prorostrum bestimmt länger als das Metarostrum.... *C. æqualis* Kleine.
   Pro- und Metarostrum gleichlang .... *C. tristriatus* Fabricius.
6. Kleine Art; Rüssel robust; Kopf hinter den Augen gerundet, Seiten der Elytren glänzend .... *C. sexsulcatus* Motschulsky.
   Grosse Art; Rüssel zart; Kopf hinter den Augen mehr oder weniger winklig; Seiten der Elytren gestreift........ *C. adustus* Senna.
7. Kopf oberseits über den Hals zurückgezogen; innen dreieckig eingekerbt. *C. costatus* Kleine.
   Oberseite des Kopfes gerade oder nur flach nach innen gebuchtet.... 8.
8. Elytren mit durchgehender dritter Furche........ *C. grouvellei* Senna.
   Elytren mit verkürzter 3. Furche........ 9.
9. Furche des Prothorax durchgehend, 1. Fühlerglied länglich. *C. sumatranus* Senna.
   Furche nur in der basalen Hälfte, 11. Fühlerglied kurz. *C. formosanus* Schönf.

TRACHELIZINI

Genus HOMOPHYLUS Kleine

Nur eine Art .... *H. mindanensis* Kleine.

Genus METATRACHELIZUS Kleine

Nur eine Art .... *M. constans* Kleine.

Genus TRACHELIZUS Schoenherr

Nur eine Art .... *T. bisulcatus* Fabricius.

Genus MIOLISPA Pascoe

1. Elytren nur auf dem Absturz gerippt-gefurcht, sonst glatt und nur zart punktiert .... 2.
   Elytren auf der ganzen Fläche gerippt-gefurcht........ 3.
2. Einfarbig schwarze Art........ *M. paucicostata* Kleine.
   Kopf, Fühler und Rüssel schwarz; Prothorax zinnoberrot; Elytren blaumetallisch .... *M. pulchella* Kleine.
3. Prothorax deutlich und kräftig längsgefurcht........ 4.
   Prothorax ganz obsolet oder ungefurcht........ 6.
4. Prothorax überall dicht und tief grubig punktiert........ 5.
   Prothorax höchstens am Hinterrande in sehr geringem Umfange oder gar nicht punktiert .... *M. fraudatrix* Kleine.
5. Einfarbige matte, schwarze Art, 3. Rippe nicht gelb. *M. unicolor* Kleine.
   Grünlich-erzfarben, glänzend, 3. Rippe gelb........ *M. persimilis* Kleine.
6. Prothorax mindestens im basalen Teil deutlich und kräftig punktiert 7.
   Prothorax unpunktiert, höchstens am Hinterrande mit engen Punkten 17.

7. Prothorax rot; Elytren schwarz .... 8.
Farbe der Elytren und des Prothorax übereinstimmend oder die Elytren hell und der Prothorax dunkel gefärbt .... 9.
8. Matte Art, 3. Rippe der Elytren nicht gelb .... *M. bicolor* Kleine.
Hochglänzende Art, 3. Rippe gelb .... *M. clavicornis* Kleine.
9. Schenkel der Mittel- und Hinterbeine verdickt, gross, klobig, Stiel kurz, breit, zusammengedrückt .... 10.
Schenkel normal, keulig, Stiel dünn, deutlich abgesetzt .... 11.
10. Kopf und Rüssel mit Ausnahme des vorderen Prorostrums matt, Körperseiten dunkel gefärbt .... *M. flexilis* Kleine.
Am ganzen Körper hochglänzend, Körperseiten hellrotbraun. *M. fornicata* Kleine.
11. Schienen aller Beine, namentlich der Vorder- und Hinterbeine mit starkem Innenzahn .... *M. formosa* Kleine.
Schienen normal ohne Zahn .... 12.
12. Rotbraune Arten, 3. Rippe gelb oder nicht .... 13.
Dunkelfarbige Arten, 3. Rippe immer gelb .... *M. flavolineata* Kleine.
13. Prothorax matt .... 14.
Prothorax hochglänzend .... 15.
14. Furche des Metarostrums zu einer sammetartigen, matten Platte vereinigt .... *M. lineata* Senna.
Nicht sammetartig, nicht vereinigt .... *M. siporana* Senna.
15. Fühlerglieder eng stehend, 2. Glied breiter als alle anderen. *M. robusta* Kleine.
Fühler normal .... 16.
16. Paramerenlamellen fingerartig, ausser der Sutura eine deutliche schwarze Makel hinter der Elytrenmitte .... *M. cruciata* Senna.
Paramerenlamellen weit getrennt, zangenartig, nur die Sutura dunkel, Makel meist fehlend, seltener unscharf vorhanden. *M. intermedia* Senna.
17. Elytren ausser der Sutura auf der ganzen hinteren Hälfte schwarz. *M. ephippium* Kleine.
Elytren rotbraun, höchstens die Sutura and eine oder zwei Makeln verdunkelt 18
18. Nur die Sutura ist dunkel gefärbt .... *M. pascoei* Kleine.
Ausser der Sutura ist noch eine dunkle Makel vorhanden .... 19.
19. Mit Ausnahme des 3. sind alle Fühlerglieder breiter als lang. *M. discors* Senna.
Mit Ausnahme des 2. sind alle Fühlerglieder länger als breit. *M. elongata* Kleine.

Genus HYPOMIOLISPA Kleine

1. Neunte und zehnte Fühlerglied lang, walzig, zylindrisch, mehrfach so lang wie die vorhergehenden, 11. so lang wie das 9. und 10. zusammen .... 2.
Neunte und zehnte Fühlerglied zwar länger als die vorhergehenden, aber niemals zylindrisch, sondern tonnenförmig, kurz, mehr oder weniger rundlich oder fast quadratisch, 11. meist kurz, zuweilen nur wenig länger als das 8. oder 9. .... 3.
2. Unterseite vom Prothorax bis zum Abdomen an den Seiten mit silberglänzenden Flecken .... *H. exarata* Desbr.

Ohne diese Flecken; Kopf, Rüssel und Unterkanten der Schenkel mit starkem Tomment bedeckt, sonst glatt................ *H. tomentosa* Kleine.

3. Schlanke, kleine Formen, Kopf mehr oder weniger quadratisch-eckig oder etwas länger als breit; Prothorax mit seinen Organen immer schwarz; Elytren niemals quer-schwarzstreifig .... 4.

Kopf mehr oder weniger robust, zuweilen gedrungen oder grössere Formen mit querem dreieckigem, niemals viereckigem Kopfe; Prothorax nur bei einigen Arten schwarz und dann ist die Grundfarbe überhaupt schwarz; die Elytren sind rot gezeichnet und die Beine sind bunt oder die Elytren sind querstreifig.. 5.

4. Der hinter den Augen liegende Teil des Kopfes ist doppelt so gross wie der Augendurchmesser, Penis mit kurzen Parameren. *H. nupta* Senna.

Der hinter den Augen liegende Teil höchstens so gross wie der Augendurchmesser; Parameren sehr lang .... *H. sponsa* Kleine.

5. Hinterrand des Kopfes an den Seiten nicht gezahnt, Augen gross, den Hinterrand berührend .... *H. ocularis* Kleine.

Kopf hinter den Augen gezahnt, die Augen den Hinterrand nicht berührend .... 6.

6. Prothorax schwarz, Elytren mit 2 schwarzen Querbinden. *H. trachelizoides* Senna.

Prothorax rotbraun, Elytren nicht mit schwarzen Bänderungen, sondern mit verdunkelter Sutura und gleichem Aussenrand, zuweilen mit undeutlichen Makel auf der Mitte der Sutura. *H. helleri* Kleine.

Genus HIGONIUS Lewis

Nur eine Art .... *H. cilo* Lewis.

Genus MICROTRACHELIZUS Senna

1. Metarostrum 3-furchig .... 2.

Metarostrum 1-furchig .... 3.

2. Kopf oberseits ungefurcht .... *M. pubescens* Senna.

Kopf oberseits gefurcht .... *M. tabaci* Senna.

3. Auf den Elytren ist die 2. Rippe nur am Absturz vorhanden, 3. durchgehend, verdickt, 4. und 5. verkürzt, 6. am Absturz verdickt, 7. normal durchgehend, die übrigen fehlen ganz........................ *M. fluxus* Kleine.

4. Rippe nicht unterbrochen, wenn auch verschmälert, keine Rippe ist verkürzt und keine fehlt .... *M. siamensis* Kleine.

Genus HOPLOPISTHIUS Senna

Nur eine Art .... *H. trichimerus* Senna.

AMORPHOCEPHALINI

Genus CORDUS Schoenherr

Nur eine Art .... *C. peguanus* Senna.

Genus LEPTAMORPHOCEPHALUS Kleine

Nur eine Art .... *L. fœderatus* Kleine.

Genus PARAMORPHOCEPHALUS Kleine

Nur eine Art .... *P. setosus* Kleine.

ARRHENODINI

Genus AGRIORRHYNCHUS Power

Nur eine Art .... *A. ignarius* Kleine.

Genus EUPEITHES Senna

Nur eine Art .... *E. dominator* Kleine.

Genus PROPHTHALMUS Lacordaire

Prothorax mit tiefer Mittelfurche........ *P. longirostris* Gyllenhal.
Prothorax ungefurcht .... *P. tricolor* Power.

Genus BARYRRHYNCHUS Lacordaire

Nur eine Art .... *B. schroederi* Kleine.

Genus EUPSALIS Lacordaire

Nur eine Art .... *E. kleinei* Heller.

Genus CAENORYCHODES Kleine

Schmuckstreifen auf den Elytren lang, 3. Rippe basal bis zur Mitte und mit kurzer Unterbrechung oder durchgehend bis zum Absturz verlängert, 4. wie die 3. oder ähnlich, niemals in kurzen Querbinden.
C. splendens Kirsch.
Schmuckstreifen nicht lang, sondern in kurzen Querbinden angelegt.
C. serrirostris Fabricius.

Genus PSEUDORYCHODES Senna

Nur eine Art .... *P. præclarus* Kleine.

Genus AMPHICORDUS K. M. Heller

Nur eine Art .... *A. improportionalis* Heller.

BELOPHERINI

Genus YPSELOGONIA Kleine

Nur eine Art .... *Y. peregrina* Kleine.

Genus HETEROBLYSMIA Kleine

1. Prothorax glatt, ohne rugosem Fleck auf der Mitte.
H. formidolosa Kleine.
Mit rugosem Fleck .... 2.
2. Violettbraun, Prothorax ziegelrot, Schmuchzeichnung auf den Elytren längsstreifig .... *H. electa* Kleine.
Einfarbig braun, Schmuckzeichnung nicht längstreifig.
H. accurata Kleine.

Genus APOCEMUS Calabresi

Nur eine Art .... *A. ignobilis* Kleine.

Genus HENARRHENODES K. M. Heller

Nur eine Art .... *H. macgregori* K. M. Heller.

Genus ECTOCEMUS Pascoe

Nur eine Art .... *E. badeni* Kirsch.

Genus ANEPSIOTES Kleine

Kopf breiter als lang; Prothorax an den Seiten mit schwarzen Makeln. *A. luzonicus* Calabresi.
Kopf quadratisch; ohne schwarze Makeln........ *A. nitidicollis* Calabresi.

ITHYSTENINI

Genus CEDIOCERA Pascoe

Nur eine Art .... *C. tristis* Senna.

Genus ACHRIONOTA Pascoe

Am ganzen Körper in der Punktierung schuppig behaart. *A. bilineata* Pascoe.
In den Punkten nicht behaart... *A. spinifer* Kleine.

Genus HETEROPLITES Lacordaire

Nur eine Art .... *H. erythroderes* Boheman.

Genus DIURUS Pascoe

1. Basales Fühlerglied höchstens mässig verlängert und an der Spitze niemals nodos verdickt .... 2.
   Basales Fühlerglied immer lang, schlank, an der Spitze nodos verdickt. 3.
2. Elytren in beiden Geschlechtern nur gedornt, Spitzenglieder der Fühler getrennt .... *D. shelfordi* Senna.
   Elytren mit deutlichen Anhängen, nicht gedornt, Spitzenglieder der Fühler dich stehend .... *D. furcillatus* Gyllenhal.
3. Zweite Fühlerglied ⅓ so lang wie das 3................ *D. philippinicus* Senna.
   Zweite und dritte Fühlerglied gleichlang............ *D. samarensis* Kleine.

PSEUDOCEOCEPHALINI

Genus OPISTHENOPLUS Kleine

1. Hinterer Augenrand deutlich gezahnt .... 2.
   Augenrand ungezahnt oder flach gekerbt.. 4.
2. Augenrand mit 3 Zähnen .... *O. fascinatus* Kleine.
   Augenrand mit 2 Zähnen .... 3.
3. Pechbraun; Tarsen der Hinterbeine des ♂ walzig, Prothorax an der Basis kräftig punktiert .... *O. madens* Lacordaire.
   Rotbraun, Tarsen der Hinterbeine des ♂ kegelig, Prothorax garnicht oder wenig punktiert .... *O. cavus* F. Walker.
4. Schwarz, Prothorax ziegelrot .... *O. calabresii* Kleine.
   Einfarbig hellrotbraun .... *O. fecundus* Kleine.

Genus HORMOCERUS Schoenherr

Nur eine Art .... *H. reticulatus* Fabricius.

Genus APTERORRHINUS Senna

Schwarz, nur die Tarsen rotbraun, Kopf nicht gefurcht, Suturalfurche gegittert .... *A. albatus* Kleine.
Rotbraun, Kopf tief gefurcht, Suturalfurche nur punktiert, nicht gegittert .... *A. compressitarsis* Senna.

Genus SCHIZOTRACHELUS Lacordaire

1. Kopf etwa quadratisch oder wenig länger als breit .... 2.
   Kopf schmal, viel länger als breit, parallel oder oblong .... 3.
2. Schwarze Art .... *S. brevicaudatus* Senna.
   Kirschrote, zuweilen etwas dunklere Art .... *S. brunneus* Kleine.
3. Zweifarbige Art, Prothorax rot, sonst violettbraun (Nominatform). *S. bakeri* Kleine.
   Einfarbige Arten .... 4.
4. Pechschwarze Art, Elytren am Hinterrand in der Mitte eingeschnitten. 5.
   Heller oder dunklerbraune Arten .... 7.
5. Prothorax tief punktiert, Elytren am Absturz mit stark verdickter 8. Rippe .... *S. imbricellus* Kleine.
   Prothorax unpunktiert oder nur mit einigen zarten Punkten, Elytren nicht mit verdickter 8. Rippe .... 6.
6. Kopf gegen den Rüssel verengt, Meta- und Prorostrum schmal gefurcht, Hinterschienen breit .... *S. angulaticeps* Senna.
   Kopf parallel; Metarostrum breit und tief gefurcht; Prorostrum ohne Furche; Hinterschienen schmal .... *S. imitator* Kleine.
7. Prothorax tief punktiert .... *S. inconstans* Kleine.
   Prothorax unpunktiert .... 8.
8. Hinterrand des Kopfes tief dreieckig eingekerbt. *S. bakeri* Kleine f. *concolor*.
   Hinterrand des Kopfes breit, flach eingekerbt .... 8.
9. Schwarzbraun, Kopf zart punktiert .... *S. corpulentus* Kleine.
   Rotbraun, Kopf unpunktiert .... *S. consimilis* Kleine.

ILLUSTRATIONEN

KARTEN

NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), XII [1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

TWO PLATES

The crane flies discussed in the present report are all from Davao district, Mindanao, Philippine Islands, where they were collected by my friend and former student Mr. Charles F. Clagg. The majority of the specimens were taken at high altitudes on Mount Apo, which was twice ascended to the summit by Mr. Clagg. Other species from this rich collection will be discussed in later parts under this general title. All types are preserved in the author's collection.

LIMONIINÆ

LIMONIINI

LIMONIA (LAOSA) MANOBO sp. nov. Plate 1, fig. 1.

Ground color of notum whitish, the præscutum with four chestnut-brown stripes; femora yellow, the tips broadly blackened; wings whitish, with an irregularly banded yellow pattern, the areas bordered by darker; the supernumerary crossvein in cell R_3 lying far distad of the one in cell R_5.

Male.—Length, about 7.5 millimeters; wing, 9.5.

Rostrum and palpi black, the former about one-half the remainder of the head. Antennæ with the scapal segments black; first flagellar segment light yellow, the remaining segments passing through brown to black; flagellar segments oval, clearly demarked, each with one seta that is a little longer than the segment, unilaterally arranged, in addition to several small setæ; terminal segment one-half longer than the penultimate, the terminal two setæ small. Head brownish gray, the center of the posterior vertex narrowly blackened, the narrow anterior vertex light golden yellow.

[1] Contribution from the entomological laboratory, Massachusetts State College.

Pronotum medially obscure yellow, dark brown sublaterally. Mesonotal præscutum with the restricted ground color whitish, the disk almost covered by four confluent chestnut-brown stripes that are narrowly bordered by blackish, the lateral stripes continued laterad to the margin, leaving a large humeral area of the ground color completely isolated from a small area before the suture; scutal lobes light orange, bordered by blackish, the median area darkened; scutellum yellow, the caudal portion with a large brown spot; postnotal mediotergite chiefly dark brown, the cephalic portion more yellowish, especially medially. Pleura whitish, extensively variegated with dark brown, the major areas including most of the anepisternum and sternopleurite, together with the pleurotergite, and a small spot on the pteropleurite. Halteres black, the base and apex of the stem narrowly and subequally light yellow. Legs with the coxæ pale yellowish white, variegated with brown; trochanters yellow; femora yellow, the tips very broadly blackened, the amount including about the distal quarter and subequal in amount on all legs; tibiæ light yellow; tarsi yellow, the outer segments blackened. Wings (Plate 1, fig. 1) whitish, with an irregularly banded brownish yellow pattern that is suggestive of that of many species of *Epiphragma;* the bands include a restricted postarcular area; a complete band at near midlength of cells R and M, widened out along vein Cu, ending at margin at vein 2d A; bands at cord and outer end of cell 1st M_2, broadly confluent in the stigmal region, the latter extended out across the supernumerary crossveins in the radial field to the margin at midlength and apex of cell R_2; all bands margined with brown; an isolated small brown spot at end of vein 1st A; cells C and Sc uniformly darkened. Venation: Sc_1 ending beyond r-m, Sc_2 close to its tip; R_1 bent strongly caudad at R_2; supernumerary crossvein in cell R_3 lying far more than its own length beyond the one in cell R_5; second section of M_{1+2} strongly sinuous; m-cu about one-half its length beyond the fork of M; cell 2d A wide.

Abdominal tergites dark brown, narrowly pale medially and sublaterally at base; hypopygium chiefly darkened. Male hypopygium almost as in the typical form of the subgenus *Libnotes*.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet, September 14, 1930 (*C. F. Clagg*); holotype, male.

Limonia (*Laosa*) *manobo* is the second species of *Laosa* to be described and the first record of the subgenus from the Philippines. It is very different from the subgenotype, *gloriosa*

(Edwards), of French Indo-China, in all details of coloration and venation, although the beautifully patterned wings are somewhat alike in the two species. The specific name, *manobo,* is that of a native tribe. It should be noted that the very peculiar structure of the male hypopygium is almost identical with that of the typical form of *Libnotes* and that the same structure has been found in at least one species of the typical subgenus, *Limonia.*

LIMONIA (LIMONIA) BILAN sp. nov. Plate 1, fig. 2.

General coloration of mesonotum obscure yellow, the præscutum with three brown stripes; antennæ black; flagellar segments subglobular, with short yellow apical pedicels; halteres orange; legs obscure yellow, the tips of the femora and tibiæ darkened; wings cream-colored, with a very heavy clouded and spotted pattern; abdomen dark brown.

Female.—Length, about 11 millimeters; wing, 10.5.

Rostrum and palpi black. Antennæ black, the basal flagellar segments subglobular, with abrupt short yellow apical pedicels; penultimate segment short-oval; terminal segment elongate, pointed at apex, about one-third longer than the penultimate; verticils longer than the segments. Head dark gray; anterior vertex (female) a trifle narrower than the diameter of the first scapal segment.

Pronotum dark brown. Mesonotal præscutum obscure yellow, with three brown stripes, the median stripe broad and entire, the lateral stripes narrow and becoming subobsolete on their mesal edges; scutum with the median area gray, the lobes chiefly blackened; scutellum large, pale gray; postnotal mediotergite blackened. Pleura black, variegated with brown on the dorsal and ventral sternopleurite and on the meron; dorsopleural region restrictedly buffy. Halteres orange. Legs with the coxæ black, the apices restrictedly paler; trochanters obscure yellow; femora obscure yellow, the tips deepening to black; trochanters obscure yellow, the tips narrowly blackened; basitarsi black, the proximal ends brown; remainder of tarsi black; claws (female) with a large outer and two progressively smaller, more basal spines. Wings (Plate 1, fig. 2) with the very restricted ground cream-colored, the prearcular and costal ground deeper yellow; a heavy dark brown costal and paler grayish brown discal pattern; the major brown areas are distributed along the costa, those at arculus and at the supernumerary crossvein in cell Sc more extensive; areas at origin of Rs and end

of Sc very narrowly divided by a line of the ground color; stigmal area in oblique alignment with a band along the cord, crossing the base of cell R_3, the area contiguous with a large spot immediately preceding it; numerous grayish brown spots and clouds in all the cells, these confluent to form a pattern that is much more extensive than the ground; veins yellow, darker in the clouded areas. Venation: Sc_1 ending just before midlength of Rs, Sc_2 at its tip; a weak supernumerary crossvein at near midlength of cell Sc; free tip of Sc_2 in alignment with R_2; cell 1st M_2 relatively small; m-cu at or just before the fork of M; anal veins at origin parallel or nearly so.

Abdomen dark brown, the two basal sternites vaguely more yellowish at base, the succeeding two segments with a linear yellow median dash; genital segment obscure fulvous. Ovipositor with the valves reddish horn color; tergal valves slender and acute.

MINDANAO, Davao district, Mount Apo, altitude 8,000 feet, September 19, 1930 (*C. F. Clagg*); holotype, female.

Limonia (*Limonia*) *bilan* is named from one of the native tribes living in the vicinity of Mount Apo. It is quite distinct from the numerous regional species of the subgenus in the abundantly spotted wings, structure of antennæ, and details of coloration.

LIMONIA (LIMONIA) ATROAURATA sp. nov. Plate 1, fig. 3.

General coloration of head and thorax intense orange, the mesonotum with two dark brown lines that extend from the præscutum to the abdomen, converging behind; a narrow black longitudinal stripe on pleura; knobs of halteres darkened; wings dirty whitish, with a heavy brown clouded and spotted pattern; Sc relatively short, Sc_1 ending about opposite one-third the length of Rs; m-cu at near one-third the length of cell 1st M_2.

Female.—Length, about 4.6 millimeters; wing, 5.

Mouth parts very small, black; palpi reduced, black. Antennæ with the scapal segments black; remainder of organ broken. Head fiery orange; anterior vertex very broad, at narrowest point fully three times the diameter of the scape.

Pronotum orange, the anterior notum behind narrowly bordered by black. Mesonotal præscutum intense orange, the usual sublateral stripes represented by brown lines, the broad median area remaining of the ground color; extreme lateral margins of sclerite narrowly and evenly bordered by brownish black, the

lines not quite meeting on the cephalic margin; remaining sclerites of mesonotum orange, traversed by narrow brown lines that converge behind and are direct prolongations of the sublateral præscutal stripes, on the postnotal mediotergite strongly approximated, being divided only by a capillary median line of the ground color. Pleura orange and yellow, with a narrow black longitudinal stripe, extending from the cervical sclerites to the abdomen, the region dorsad of this line more orange, below this line more yellow; a linear black streak at the anterior spiracle. Halteres with the stem obscure yellow, the knobs infuscated. Legs with the coxæ and trochanters yellow; remainder of legs broken, a single one detached, with the specimen and probably belonging here, is almost uniformly blackened, the femora a trifle paler. Wings (Plate 1, fig. 3) dirty whitish, with a heavy brown pattern consisting of very large clouds and washes; the major clouds are at arculus; origin of Rs and tip of Sc; stigma; along cord and outer end of cell 1st M_2; beyond midlength of cells R_2 and R_3; large clouds at ends of anal veins, with an additional major area at midlength of cell 2d A; cells R and M extensively washed with brown; veins pale, darker in the clouded areas. Venation: Sc short, Sc_1 ending at near one-third the length of Rs, Sc_2 close to its tip; Rs relatively short, angulated and spurred at origin; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 rectangular, a little shorter than vein M_{1+2} beyond it; m-cu at one-third the length of cell 1st M_2, subequal to the distal section of Cu_1; anal veins bent rather strongly into the margin, especially 2d A.

Abdominal tergites velvety black laterally, more brownish black medially, the caudal margin medially of each segment with a narrow transverse obscure yellow line, on the basal tergite much more extensive and almost covering the segment; subterminal segments more uniformly brown; genital segment reddish brown; sternites pale brown, the caudal margins narrowly ocherous. Ovipositor with the tergal valves (cerci) small and strongly upcurved; sternal valves (hypovalvæ) longer, straight, blackened at bases.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet, September 14, 1930 (*C. F. Clagg*); holotype, female.

This beautiful little *Limonia* is very different from any other fly in the Philippine fauna. The short Sc is distinctive of the subgenus *Limonia;* but the distal position of m-cu is a rare condition in this subgenus, being more characteristic of *Libnotes*.

LIMONIA (LIMONIA) BAGOBO sp. nov. Plate 1, fig. 4; Plate 2, fig. 23.

General coloration obscure yellow; front silvery; antennæ, halteres, and legs blackened; basal flagellar segments subglobular, terminal segment elongate; wings with a blackish tinge; cell 1st M_2 open by atrophy of the basal section of M_3; male hypopygium with the dististyle single, at apex produced into an acute blackened spine.

Male.—Length, about 3.5 millimeters; wing, 4.2.

Rostrum and palpi very much reduced, black. Antennæ black throughout; flagellar segments subglobular, the outer ones passing into oval; terminal segment elongate, narrowed outwardly, about one-half longer than the penultimate; verticils short, unilaterally arranged, on outer segments becoming smaller and insignificant. Head brown, the broad frontal region silvery white.

Mesonotum deep yellow, without distinct markings, the pleura paler yellow. Halteres dusky, the knobs blackened. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs black; claws apparently simple or with setæ only. Wings (Plate 1, fig. 4) with a strong blackish suffusion; veins slightly darker. Venation: Sc_1 ending about opposite one-third to two-fifths the length of Rs, Sc_2 at its tip; free tip of Sc_2 some distance before the arcuated R_2; cell 1st M_2 open by the atrophy of the basal section of M_3, cell 2d M_2 a trifle longer than its petiole; m-cu a short distance beyond the fork of M.

Abdomen, including the hypopygium, dark brown. Male hypopygium (Plate 2, fig. 23) with the tergite, *9t*, elongate, slightly longer than wide, the apex bilobed, provided with long conspicuous setæ. Basistyle, *b*, elongate, the ventromesal lobe slender. Dististyle, *d*, single, oval, narrowed outwardly, at apex produced into an acute blackened spine; on outer face of basal half with a circular pale area provided with a small tubercle bearing two short stout setæ. Gonapophyses, *g*, with the mesal-apical lobe appearing as an acute blackened hook.

MINDANAO, Davao district, Mount Apo, Bakraeyon, altitude 8,000 feet, September 16, 1930 (*C. F. Clagg*); holotype, male.

Limonia (*Limonia*) *bagobo* is named from one of the native tribes inhabiting Mount Apo and surrounding country on the west side of Davao Gulf. The species is very distinct in the venation and structure of the male hypopygium. The peculiar bisetose tubercle on the dististyle of the hypopygium would indicate a relationship with the otherwise very different *L.* (*L.*) *canis* Alexander and *L.* (*L.*) *cynotis* Alexander.

LIMONIA (LIMONIA) SUBPACATA sp. nov. Plate 1, fig. 5; Plate 2, fig. 24.

Male.—Length about 3 millimeters; wing, 3.8.

Female.—Length, about 3.5 millimeters; wing, 4.

Closely related to *L.* (*L.*) *pacata* Alexander and *L.* (*L.*) *prolixicornis* Alexander; differing especially in the venation and structure of the male hypopygium.

Antennæ (male) of moderate length, the flagellar segments short-cylindrical, almost as in *subprolixa* sp. nov. and much shorter than in *prolixicornis*. Head dark.

Thorax light reddish yellow, without distinct markings. Halteres with dusky knobs. Legs chiefly pale testaceous brown, the outer tarsal segments darkened. Wings (Plate 1, fig. 5) grayish subhyaline, the stigma not or scarcely differentiated; veins pale brown. Venation: Sc very short, Sc_1 ending shortly beyond the origin of Rs, with Sc_2 immediately beyond this origin; cell 2d A very narrow.

Abdomen reddish brown, the sternites paler. Male hypopygium (Plate 2, fig. 24) with the lateral lobes of the tergite, *9t*, pale, glabrous, the caudal margin between the lobes emarginate. Gonapophyses, *g*, with the lateral lobe darkened, the mesal-apical lobe pale, very broad, the apex obtusely rounded.

MINDANAO, Davao district, Mount Apo, Sibulan River, altitude 7,000 to 8,000 feet, September 21, 1930 (*C. F. Clagg*); holotype, male; allotype, female.

The present species differs from all described species of the *pacata* group in the unusually short Sc which extends only a short distance beyond the origin of Rs. The male hypopygium furnishes ready identification characters to separate this fly from *prolixicornis* Alexander and *subprolixa* sp. nov.

LIMONIA (LIMONIA) SUBPROLIXA sp. nov. Plate 1, fig. 6; Plate 2, fig. 25.

Belongs to the *pacata* group; antennæ of male elongate but shorter than in *prolixicornis;* Sc_1 ending beyond midlength of Rs; hypopygium with the tergite terminating in two stout lobes, each bearing five powerful setæ; male hypopygium with the mesal apical lobe of the gonapophyses long and slender.

Male.—Length, about 4 to 4.5 millimeters; wing, 4.5 to 5.5.

Female.—Length, about 5.5 to 6 millimeters; wing, 5.5 to 5.8.

Rostrum and palpi brownish black. Antennæ (male) elongate, but still shorter than in *prolixicornis;* flagellar segments cylindrical, with short apical pedicels. Head dark brownish gray.

Mesonotal præscutum reddish brown, without distinct markings, the posterior sclerites of the notum darker medially.

Pleura yellow, the dorsal pleurites usually darker. Halteres dusky, the knobs infuscated. Legs with the fore coxæ more or less darkened on outer face, the other coxæ and all trochanters yellow; remainder of legs brownish black, the femoral bases restrictedly obscure yellow. Wings (Plate 1, fig. 6) with a brownish tinge, the oval stigma a trifle darker brown; veins dark brown. Venation: Sc_1 ending beyond midlength of Rs, Sc_2 a short distance from its tip; cell M_2 open by the atrophy of m; m-cu at or close to the fork of M.

Abdominal tergites dark brown, the sternites obscure yellow or brownish yellow. Male hypopygium (Plate 2, fig. 25) with the tergal plate, *9t*, narrow, conspicuous, at apex with two lobes, each bearing about five stout marginal setæ. Basistyles and dististyles almost as in *prolixicornis*. Gonapophyses, *g*, with the mesal-apical lobe long and slender, gently curved, the apex truncated. Ædeagus with unusually wide lateral flanges.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, 7,000 to 8,000 feet, September 20, 1930; allotype, female, altitude 8,000 feet, September 19, 1930; paratypes, 15 males and females, 6,500 to 8,000 feet, September 5 to 30, 1930.

Limonia (*Limonia*) *subprolixa* is most closely allied to *L.* (*L.*) *prolixicornis* Alexander, differing in the shorter antennæ of the male and the details of structure of the male hypopygium, especially the tergite and gonapophyses.

HELIUS (HELIUS) PROCERUS sp. nov. Plate 1, fig. 7; Plate 2, fig. 26.

General coloration dark brown; rostrum black, slightly longer than the head; antennæ (male) elongate, if bent backward extending nearly to the base of abdomen; legs black, the tarsi paling to yellow; wings with a faint blackish tinge; anterior branch of Rs strongly arcuated at origin and thence running close to and generally parallel to R_1; cell 1st M_2 long-rectangular, with m-cu shortly beyond its base.

Male.—Length, about 7 millimeters; wing, 7.8.

Female.—Length, about 8 millimeters; wing, 7.2.

Rostrum slightly longer than the remainder of head, black; palpi black. Antennæ (male) unusually elongate for this genus, if bent backward extending nearly to base of abdomen; black throughout; flagellar segments cylindrical, with abundant short dense erect setulæ. Antennæ (female) short, only a little longer than the head. Head black.

Pronotum dark medially, obscure yellow laterally. Mesonotal præscutum dark brown, without distinct markings; me-

dian region of scutum and vicinity of the suture yellow; posterior sclerites of mesonotum darker brown. Pleura dark brown dorsally, more yellowish brown ventrally. Halteres infuscated. Legs with the coxæ brownish testaceous; trochanters yellowish testaceous; remainder of legs blackened, the terminal tarsal segments paling to yellowish. Wings (Plate 1, fig. 7) with a faint blackish tinge, cells C and Sc dark brown, confluent with the scarcely differentiated brown stigma; veins dark brown. Venation: Sc_1 ending some distance beyond r-m, Sc_2 faint or obsolete; r-m on R_{4+5} shortly beyond the fork of Rs; anterior branch of Rs very strongly arcuated at base, at the level of the end of Sc running generally parallel and close to R_1; Rs nearly in alignment with the distal section of R_{4+5}; cell 1st M_2 long-rectangular, shorter than any of the veins beyond it; m-cu a short distance beyond the fork of M.

Abdomen, including the hypopygium, brownish black. Male hypopygium (Plate 2, fig. 26) with the mesal face of basistyle, *b*, at cephalic end with a conspicuous lobe that is covered with abundant spinous setæ. Outer dististyle, *od*, a simple blackened rod, the apex entire. Inner dististyle stout and with conspicuous setæ on basal two-thirds, the apex suddenly narrowed. Gonapophyses, *g*, with the mesal angle a long, slender tail-like spine.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Mainit River, altitude 6,000 feet, September 4, 1930; allotype, female, Galog River, attracted to camp fire, altitude 6,000 feet, September 22, 1930; paratype, a fragmentary specimen, altitude 7,000 feet, September 11, 1930.

Helius (*Helius*) *procerus* is most closely allied to *H.* (*H.*) *arcuarius* Alexander (Luzon), differing most evidently in the large size and elongate antennæ of the male sex.

HELIUS (HELIUS) APOENSIS sp. nov. Plate 1, fig. 8.

General coloration pale yellow ocherous, without markings; head blackish gray; wings ocher brown, the stigma a little darker; wings with cell R_1 closed by the apical fusion of veins R_{1+2} and R_3.

Male.—Length, about 3 millimeters; wing, 3.5 to 3.6.

Rostrum and palpi black. Antennæ black throughout. Head blackish gray.

Pronotum brown. Mesothorax light yellow ocherous, unmarked, the scutellum a little paler. Halteres pale, the knobs slightly darkened. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs pale brownish yellow, the ter-

minal tarsal segments brighter yellow. Wings (Plate 1, fig. 8) pale ocher brown, the pale stigma only slightly indicated; veins pale brown. Costal fringe (male) conspicuous. Venation: Almost as in *trianguliferus;* anterior branch of Rs shorter and more erect at origin, the fusion with R_{1+2} slightly longer.

Abdomen pale brownish yellow.

MINDANAO, Davao district, Mount Apo, altitude 7,000 feet, September 11, 1930 (*C. F. Clagg*); holotype, male; paratype, male.

Very similar and closely related to *Helius* (*Helius*) *trianguliferus* Alexander (Luzon-Mindanao), differing especially in the light ocher-yellow coloration of the body.

THAUMASTOPTERA (THAUMASTOPTERA) MACULIVENA sp. nov. Plate 1, fig. 9; Plate 2, fig. 27.

General coloration pale yellow; antennal scape black, the flagellum yellow; knobs of halteres weakly infuscated; legs pale yellow, the genua very restrictedly to scarcely darkened; wings grayish white with a conspicuous brown and gray pattern that appears as seams to the veins; Sc relatively short; r-m shortened by approximation of the adjoining veins; male hypopygium with the dististyle slender, its tip pointed.

Male.—Length, about 2.5 millimeters; wing, 3.5.

Rostrum brownish black; palpi black. Antennæ with the scape black, the flagellum abruptly light yellow; flagellar segments subglobular to short-oval, with long conspicuous verticils that much exceed the segments. Head brown.

Mesonotum pale yellow, in cases the postnotal mediotergite a trifle darker. Pleura pale yellow. Halteres pale, the knobs weakly infuscated. Legs with the coxæ and trochanters pale yellow; remainder of legs pale yellowish white, the genua very restrictedly to almost insensibly darkened. Wings (Plate 1, fig. 9) with the ground color grayish white, the prearcular and costal regions clearer cream yellow; a restricted brown and gray pattern appearing as seams along the veins, arranged as follows: Arculus, including the surrounding veins; origin of Rs and opposite portion of costa; cord; ends of longitudinal veins from M_{1+2} to anal veins, inclusive; a cloud on costa at near three-fourths the length of cell R_2; at midlength of vein R_{4+5}; m and adjoining parts of M_{1+2} and M_3; m-cu; at near midlength of basal section of Cu_1; a second dash on vein 2d A on basal half; a weak axillary darkening; veins pale yellow, brown in the clouded areas. Costal fringe relatively long. Venation: Sc of mod-

erate length, Sc_1 ending about opposite one-third the length of Rs, Sc_2 some distance from its tip, opposite or close to origin of Rs, the latter angulated and long- or short-spurred at origin; r-m short, reduced by approximation of adjoining veins.

Abdomen yellow, including the hypopygium. Male hypopygium (Plate 2, fig. 27) with the dististyle, *d*, slender, pale, terminating in an acute pale spinous point, with one long pale seta on outer margin before apex, together with a row of four black setæ on inner margin, distributed over the outer half; additional setæ on inner face at base. Ædeagus, *a*, short.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet, September 26, 1930; Mainit River, altitude 6,000 to 6,500 feet, September 6 to 14, 1930 (*C. F. Clagg*); holotype, male; paratypes, 3 males.

It should be noted that this is the first record of the typical subgenus of *Thaumastoptera* in the eastern Asiatic area, the only other member of the genus so far discovered in Asia being *Thaumastoptera* (*Taiwanita*) *issikiana* Alexander, from the high mountains of Formosa. The present species is very distinct from the genotype, *calceata* Mik, in the wing pattern.

HEXATOMINI

ADELPHOMYIA APOANA sp. nov. Plate 1, fig. 10.

General coloration dark brown; antennæ 16-segmented, dark throughout; wings with a faint brown tinge, with a restricted darker brown pattern, including the stigma and narrow seams at origin of Rs and along cord; macrotrichia of membrane relatively sparse.

Female.—Length, about 4 millimeters; wing, 4.3.

Rostrum and palpi black. Antennæ black, the flagellar segments somewhat paler; sixteen distinct segments, the basal ones shorter and more crowded; outer segments long-cylindrical, with long verticils that exceed the segments; terminal segment about one-half longer than the penultimate. Head dark brown.

Thorax almost uniform brown, the central portion of the præscutum darker. Pleura a trifle more testaceous brown than the notum. Halteres elongate, dusky, the base of the stem restrictedly pale. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs brown, with long outspreading setæ. Wings (Plate 1, fig. 10) with a faint brown tinge, with a very restricted, slightly darker brown pattern, including the stigma and narrow seams at origin of Rs and along the cord;

veins pale brown. Macrotrichia of cells relatively sparse, in the outer ends of cells R_2 to M_3, inclusive. Venation: Sc_1 ending shortly before the fork of Rs, Sc_2 some distance from its tip; Rs weakly angulated at origin; m-cu at near midlength of lower face of cell 1st M_2; cell M_1 present.

Abdomen brownish black. Ovipositor with the elongate tergal valves darkened at bases, the slightly upcurved acute tips yellow.

MINDANAO, Davao district, Mount Apo, Kidopawan trail to Lake Lino, altitude 7,000 to 8,000 feet, September 20, 1930 (*C. F. Clagg*); holotype, female.

Adelphomyia apoana is apparently distinct from any of the now rather numerous regional species in the wing pattern, venation, and conformation, and in the relatively sparse macrotrichia of the membrane. The nearest ally seems to be *A. carbonicolor* Alexander.

ADELPHOMYIA PAUCISETOSA sp. nov. Plate 1, fig. 11; Plate 2, fig. 28.

General coloration black; antennæ 15-segmented, the fusion segment yellow, remainder of organ darkened; wings milk white with a heavy brown pattern that is distributed chiefly as narrow broken crossbands; macrotrichia of membrane very sparse, being restricted to a few trichia in ends of cells R_3 and R_4; male hypopygium with the outer dististyle bearing a long erect spine on inner face at near midlength.

Male.—Length, about 3 millimeters; wing, 3.8.

Rostrum and palpi brownish black. Antennæ with the scape black, the fusion segment pale yellow; remainder of flagellum brown; antennæ with fifteen segments, the short-conical fusion segment involving two segments; outer flagellar segments subcylindrical, with verticils that exceed the segments in length; terminal segment about one-fourth longer than the penultimate. Head black.

Pronotum obscure brownish yellow medially, blackened laterally. Mesonotal præscutum yellowish brown to chestnut, darker medially; scutal lobes light brown; posterior sclerites of mesonotum dark brown. Pleura black. Halteres chiefly pale yellow, the central portion of stem vaguely darker. Legs with the fore coxæ brownish yellow, the remaining coxæ black; trochanters testaceous; remainder of legs brown, the outer tarsal segments somewhat darker; no tibial spurs; segments of legs with long conspicuous setæ. Wings (Plate 1, fig. 11) milky white, with a heavy brown pattern that is arranged chiefly as six or

seven, narrow, broken crossbands, interrupted at the central portion of the disk; basal band beyond arculus, complete; second band at origin of Rs and end of vein 2d A, broken in cells M and Cu; third band at Sc_2 and end of 1st A, interrupted but replaced in a slightly more distal position by a similar seam along cord; an interrupted irregular band includes the stigma, outer end of cells 1st M_2 and M_4; an outer band includes end of R_3, and a prolongation of the area across cells R_5 and 2d M_2; additional brown clouds at ends of veins R_4 and R_5; paler washes in cells M, Cu, and at midlength of cell 2d A; veins pale, darker in the clouded areas. Macrotrichia of cells very sparse, being restricted to a group of five or six in outer end of cell R_4, with one or two more in cell R_3. Venation: Sc_1 ending about opposite the end of Rs; veins R_3 and R_4 slightly upcurved at ends; R_2 at fork of R_{3+4}; cell M_1 present; cell 1st M_2 strongly narrowed at proximal end, r-m being correspondingly lengthened, arcuated.

Abdomen chiefly black, including the hypopygium. Male hypopygium (Plate 2, fig. 28) with the outer dististyle, *od*, an elongate-oval blackened structure, terminating in two slender spines, one being slightly more curved; just beyond midlength of style on inner margin a long slender erect spine. Inner dististyle, *id*, very stout at base, the obtuse tip narrowed.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,000 feet, September 22, 1930 (*C. F. Clagg*); holotype, male.

Adelphomyia paucisetosa most closely resembles *A. nebulosa* (de Meijere), of western Java, differing from all known species in the very notable reduction in number of macrotrichia of the wings, a condition which presages their total loss.

EPIPHRAGMA (POLYPHRAGMA) FUSCOFASCIATA sp. nov. Plate 1, fig. 12.

General coloration of mesonotum ocherous brown, dark brown laterally; pleura and pleurotergite black; antennal scape and fusion segment of antenna pale; halteres black; wings yellow, with three more or less complete crossbands of brownish black, the third band at the cord, very broad but more or less interrupted by pale; wing tip pale, with small dark spots at ends of the veins.

Female.—Length, about 7 millimeters; wing, 7.5.

Rostrum yellowish gray; palpi black. Antennæ with the first scapal segment light brown; second segment obscure yellow; fusion segment bright orange; remainder of flagellum black. Head yellowish gray, the central and posterior portions of the vertex darker.

Pronotum obscure yellow, deepening to black on sides. Mesonotal præscutum ocher brown sublaterally, darker brown medially, the lateral margins narrowly and abruptly dark brown; scutal lobes dark brown; scutellum black, the parascutella somewhat paler; postnotal mediotergite obscure yellowish brown, blackened posteriorly. Pleura and pleurotergite black. Halteres black. Legs with the fore coxæ dark brown, the remaining coxæ black; trochanters brownish yellow; femora yellow, darkened subterminally; remainder of legs yellow. Wings (Plate 1, fig. 12) with the ground color yellow, with three heavy crossbands of brown to brownish black; basal area including the arcular region; second band at origin of Rs; third band very broad, extending from before the cord to the level of R_3, interrupted by a few small yellow areas, as in cells Sc_2, R_2, 1st M_2, M_3, and M_4; wing apex pale, varied by a series of marginal brown areas at ends of veins R_4 to M_2, inclusive; the yellow alternating crossbands are slightly clouded with dusky in the cubital and anal fields, leaving clear yellow margins bordering the crossbands; veins yellow, dark in the infuscated areas. In the paratypes, the outer band is more extensively interrupted by pale markings. Venation: Crossveins and spurs in cell C very much restricted in number; Rs square and weakly spurred at origin; cell 1st M_2 relatively small.

Abdomen rather light brown, the caudal margins of the segments narrowly but conspicuously brownish black; genital segment obscure yellow; valves of ovipositor horn-colored, the bases of the cerci darker.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, female, Galog River, altitude 5,000 to 6,000 feet, September 12, 1930; paratypes, two females, Sibulan River, altitude 7,000 to 8,000 feet, September 21, 1930; one female, Kidopawan trail from Lake Lino, altitude 7,000 to 8,000 feet, September 20, 1930.

Epiphragma (*Polyphragma*) *fuscofasciata* is distinguished from other members of the *ochrinota* group by the handsomely banded wing pattern.

EPIPHRAGMA (POLYPHRAGMA) LATITERGATA sp. nov. Plate 2, fig. 29.

General coloration of mesonotum brownish yellow, contrasting with the blackened pleura; legs yellow, the femora with a broad pale yellow subterminal ring; wings with the ground color light brown, with a heavier brown pattern that is narrowly margined with light yellow; male hypopygium with the lateral lobes of the tergite broad, obtuse; interbasal process at apex expanded

at apex into a truncated blade, the outer apical angle bearing a small, curved, beaklike spine.

Male.—Length, about 7.5 to 8 millimeters; wing, 8 to 9.

Female.—Length, about 9 to 10 millimeters; wing, 9 to 9.5.

Rostrum and palpi dark brown. Antennæ with the first scapal segment blackened, the second obscure brownish yellow; basal flagellar segments not distinctly united into a fusion segment, beyond the base black, the verticils exceeding the segments in length. Head dull yellowish gray, the posterior vertex more reddish brown, the caudal portions more infuscated on either side of the midline.

Mesonotum dull brownish yellow, without markings, the lateral portions of the præscutum deep chestnut orange. Pleura blackened, as in the group, the ventral sternopleurite remaining yellowish. Halteres yellow, the knobs dark brown. Legs with the coxæ obscure yellow, narrowly darkened basally, especially the posterior coxæ; trochanters yellow; femora yellow, with a broad pale brown subterminal ring; remainder of legs light yellow, the terminal tarsal segments passing into fulvous. Wings with the ground color light brown with a heavier brown pattern, arranged as in the group, the major areas being at arculus; origin of Rs; along cord and outer end of cell 1st M_2; fork of M_{1+2}; and as conspicuous circular marginal clouds at ends of all longitudinal veins; the dark pattern is narrowly but conspicuously bordered by pale yellow; costal margin yellow, beyond the region of the stigma appearing as three isolated spots in outer ends of cells R_2, R_3, and R_4; veins dark, obscure yellow in the costal interspaces. No dilation of the axillary region. Venation: Spurs and supernumerary crossveins in cell C six to eight in number, all seamed by darker; Rs relatively long, angulated and weakly spurred at origin; m-cu variable in position, at one-fourth to midlength of cell 1st M_2.

Abdomen chiefly dark brown, including the sternites and hypopygium. Male hypopygium (Plate 2, fig. 29) generally as in *fulvinota* but differing in some important regards, notably the broad, obtuse lobes of the tergite, *9t*, and the shape of the interbasal processes, *i*. These latter normally are expanded at apex into a squarely truncated blade that bears on outer apical angle a small, curved hooklike spine.

MINDANAO, Davao district, Mount Apo, altitude 5,000 to 8,000 feet, August 31 to September 21, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratopotypes, several of both sexes.

Among the species of the *ochrinota* group, the present fly is closest to *Epiphragma* (*Polyphragma*) *fulvinota* Alexander, from which it differs most evidently in the wing pattern, with conspicuous narrow yellow margins to the darkened areas, the paler brown femoral annuli, and the structure of the male hypopygium, notably of the tergite and interbasal processes.

EPIPHRAGMA (POLYPHRAGMA) NIGROTIBIATA sp. nov. Plate 1, fig. 13; Plate 2, fig. 30.

General coloration of mesonotum yellow, variegated with dark brown; pleura yellow, with scattered small dark brown spots; femora yellow basally, the distal half black, inclosing two narrow yellow rings; tibiæ black; tarsi yellow; wings brownish yellow, the cephalic portion deeper yellow, the surface with a heavy brown pattern.

Male.—Length, about 7.5 millimeters; wing, 8.5.

Rostrum and palpi black. Antennæ relatively short; scapal segments brown, the fusion segment and second segment of flagellum orange; remainder of flagellum black; verticils exceeding the segments in length. Head brownish gray, the lateral portions of the vertex and the genæ more reddish brown.

Pronotum yellow, the anterior notum variegated with dark brown on the sides. Mesonotal præscutum yellow, variegated with dark brown medially, the area broad and entire behind, becoming bifid and obsolete in front; sublateral portions of the sclerite deeper reddish yellow than the pollinose interspaces; extreme lateral margins of præscutum dark brown; scutal lobes reddish brown, margined with slightly darker brown, the cephalic lateral portions brighter; scutellum brown; postnotal mediotergite dark brown, pruinose. Pleura yellow, variegated with scattered brown areas, located on the dorsal anepisternum, dorsal sternopleurite, ventral sternopleurite, meron, and dorsal and ventral pleurotergite. Halteres dark brown, the base of the stem light yellow. Legs with the coxæ and trochanters yellow, the posterior coxæ a little darker apically; femora yellow basally, the outer half passing into black, inclosing a narrow apical and a slightly wider subapical yellow ring; tibiæ black, the extreme base yellow; tarsi light yellow, the terminal segments darkened. Wings (Plate 1, fig. 13) brownish yellow, the prearcular, costal, and radial fields deeper yellow; a heavy brown pattern, distributed as follows: A series of narrow costal and subcostal areas surrounding the crossveins and spurs in the former cell; larger areas at arculus; origin of Rs; along cord; outer end of cell 1st

M_2; fork of M_{1+2}; marginal clouds at ends of all longitudinal veins, largest on the anals; a restricted dark area in axillary region; radial and medial cells beyond the level of the fork of M_{1+2} extensively darkened, confluent with the marginal dark areas in this field to produce a radiate appearance; dark areas behind the costa narrowly bordered by cream yellow; veins pale brown, darker in the infuscated areas. Venation: A series of supernumerary crossveins and spurs in cell C; m-cu more than one-half its length beyond the fork of M; supernumerary crossvein in cell Cu atrophied or nearly so.

Abdominal tergites dark brown, the basal ring of the second segment obscure yellow laterally; impressed transverse lines of the remaining tergites narrowly bordered by pale; sternites obscure yellow, the extreme caudal margins of the segments darkened. Male hypopygium (Plate 2, fig. 30) with the interbasal process, *i*, a slender rod from a dilated base, the apex weakly expanded and further produced into a small curved point. Outer dististyle, *od*, dilated at midlength, the apex a strongly curved spine.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet, September 14, 1930 (*C. F. Clagg*) ; holotype, male.

Epiphragma (*Polyphragma*) *nigrotibiata* is well-distinguished by the uniformly black tibiæ and the pattern of the femora.

EPIPHRAGMA (POLYPHRAGMA) APOENSIS sp. nov. Plate 1, fig. 14; Plate 2, fig. 31.

General coloration of mesonotum yellow, the disk with three confluent brown stripes; pleura chiefly yellow, margined with brownish black; femora yellow with a broad black subterminal ring; wings pale brown, with a heavy dark brown pattern that is narrowly bordered by cream yellow; male hypopygium with the lateral lobes of the tergite broad; interbasal process a simple blade terminating in a small beak.

Male.—Length, about 7.5 millimeters; wing, 8.5.

Rostrum brown; palpi black. Antennæ with the scape light brown; fusion segment small, yellow; remainder of flagellum black; basal flagellar segments short-oval, the outer segments subcylindrical, with verticils that are about as long as the segments. Head above with the central area dark brown, paling to reddish on sides of posterior vertex.

Pronotum yellow, dark brown laterally. Mesonotal præscutum yellow, the extreme lateral margin dark brown; disk of præscutum almost covered by three confluent brown stripes that are further divided by a capillary dark brown vitta; scutal lobes

brown, the extreme cephalic-lateral angles brightened; posterior sclerites of mesonotum yellowish brown, the postnotal mediotergite darker medially. Pleura chiefly yellow, variegated with brownish black on the margins, including the dorsopleural membrane, cephalic and ventral margin of sternopleurite, meron and dorsal and ventral portions of pleurotergite. Halteres long, pale yellow, the knobs infuscated. Legs with the coxæ and trochanters yellow; only a single (hind) leg remains; femora yellow, brighter yellow on distal fourth, this area inclosing a broad black ring; tibiæ and tarsi yellow. Wings (Plate 1, fig. 14) with the ground color pale brown, with a heavy dark brown pattern that is bordered by narrow cream-yellow margins; costal brown pattern including both cells C and Sc, with three costal areas passing into a large solid marking at origin of Rs; an hourglass-shaped darkening at the cord; wing apex beyond cell 1st M_2 chiefly darkened, variegated by yellow marginal areas in the outer ends of cells R_3, R_4, M_1, and 2d M_2, together with small paler yellow spots in bases of cells M_1, 2d M_2, and M_3; a large darkened mark at end of vein 2d A, extending to Cu; axilla darkened; a large area at arculus; veins pale yellow in the ground, darker in the clouded portions. Venation: Costal spurs and crossveins numerous, including about four beyond the origin of Rs, the latter angulated and spurred at origin; m-cu about one-half its length beyond the fork of M.

Abdominal tergites dark brown, the basal ring brighter, especially laterally; sternites extensively yellowish, the caudal margins darkened; hypopygium chiefly darkened. Male hypopygium (Plate 2, fig. 31) with the lateral lobes of the ninth tergite, *9t*, broad, separated by a deep notch. Interbasal process, *i*, a relatively narrow blade, the apex a small curved beak. Outer dististyle, *od*, with the main body spinous on outer margin, the apex a long curved spine.

MINDANAO, Davao district, Mount Apo, Seliban River, altitude 7,000 feet, September 11, 1930 (*C. F. Clagg*); holotype, male.

Belongs to the *fuscosternata* group, having the mesonotum and pleura conspicuously variegated yellow and brown. The type of hypopygium is much like that of *E.* (*P.*) *fulvinota* that belongs to the *ochrinota* group, the resemblance being especially striking in the general features of the interbasal process and dististyles.

EPIPHRAGMA (POLYPHRAGMA) HASTATA sp. nov. Plate 2, fig. 32.

General coloration of mesonotal præscutum dark brown, margined with yellow; pleura yellow, variegated with dark brown; femora yellow, with a broad subterminal dark brown to

brownish black ring; wings with a heavy dark brown pattern that is bordered by cream yellow; male hypopygium with the lobes of the ninth tergite broad, microscopically roughened at apices; interbasal rod an acute spearlike point.

Male.—Length, about 9 millimeters; wing, 10.

Rostrum light brown; palpi dark brown. Antennæ with the scape brownish yellow; basal three flagellar segments light yellow, the remainder passing into dark brown; no distinctly developed fusion segment. Head orange, the center of the vertex infuscated.

Pronotum yellow. Mesonotal præscutum yellow laterally, margined narrowly with dark brown; disk almost covered by three confluent dark brown stripes, the region of the interspaces more yellowish pollinose; scutal lobes dark brown; median area of scutum and the scutellum pale, yellowish pollinose; postnotal mediotergite brown, with a more yellow pollinose area on either side at midlength. Pleura yellow pollinose, variegated with dark brown, including the anterior dorsopleural region, the anterior margin of the anepisternum and sternopleurite, the meron, and the dorsal and ventral pleurotergite. Halteres pale yellow, the knobs infuscated. Legs with the coxæ and trochanters orange yellow, the posterior coxæ and cephalic face of the fore coxæ darkened; femora yellow, with a very broad dark brown (fore femora) to brownish black (posterior femora) subterminal ring; remainder of legs yellow. Wings with the ground color pale brown, with a heavy dark brown pattern; prearcular and costal portions deeper yellow; brown areas bordered by creamy margins; dark markings in cells C and Sc numerous; major dark areas arranged as follows: Arculus; origin of Rs, with a more-elongate area in alignment at the supernumerary crossvein in cell Cu and end of vein 2d A, interrupted at cell M; along cord, narrowed in the medial field; outer end of cell 1st M_2; ends of all longitudinal veins, continued back along the veins; veins light brown, darker in the infuscated areas, more yellow in the flavous interspaces.

Abdominal tergites chiefly dark brown, the basal rings paler; sternites more yellowish, the incisures narrowly darkened; hypopygium with the basistyles pale. Male hypopygium (Plate 2, fig. 32) with the lateral lobes of the tergite, *9t,* broad, microscopically roughened at apices, separated by a deep U-shaped notch. Interbasal process, *i,* an acute spearlike rod. Outer dististyle, *od,* terminating in an acute curved spine.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, altitude 6,000 feet, August 30, 1930; allotype, female, altitude 7,000 feet, September 11, 1930.

Epiphragma (*Polyphragma*) *hastata* belongs to the *fuscosternata* group, being most closely allied to *E.* (*P.*) *fuscosternata* Alexander and *E.* (*P.*) *apoensis* sp. nov. It differs from the latter in the distinctive structure of the male hypopygium and from the former (the male of which is still unknown) in the more-restricted amount of dark coloring in the anal cells of the wing.

EPIPHRAGMA (POLYPHRAGMA) CANINOTA sp. nov. Plate 1, fig. 15; Plate 2, fig. 33.

General coloration of dorsum of head and mesonotum light ashy gray; knobs of halteres infuscated; legs yellow; wings of both sexes with a conspicuous axillary crenulation; radial cells clouded with brown; darkened areas of wing not bordered by paler.

Male.—Length, about 6.5 millimeters; wing, 7.5.

Female.—Length, about 8.5 millimeters; wing, 8.2.

Rostrum reduced, pale brown. Antennæ with the scape and fusion segment pale yellow, the remainder of the flagellum black. Head above light ashy gray, the posterior slope of the vertex, together with the genæ, more orange yellow, infuscated medially.

Mesonotum above light ashy gray on the dorsomedian portion, the sides of the præscutum and postnotal mediotergite abruptly orange yellow. Pleura yellow. Halteres yellow, the knobs infuscated. Legs yellow, the terminal tarsal segments darkened. Wings (Plate 1, fig. 15) yellowish brown, the costal margin light yellow, continued to the wing tip in the radial field but here broken into spots by brown clouds at the ends of the veins; radial field extensively suffused with brown; additional brown clouds and spots at arculus; origin of Rs; cord; outer end of cell 1st M_2; fork of M_{1+2}; at supernumerary crossveins in cells C and Cu, and as large marginal clouds at ends of the veins; veins brownish yellow, darker in the clouded areas. Axillary crenulation large and conspicuous, a trifle less developed in female than in male. Venation: Supernumerary crossvein in cell Cu well-preserved in both sexes; m-cu in male at fork of M, in female, beyond the fork but with the crossvein in transverse alignment with the other elements of the cord.

Abdominal tergites yellowish brown, darker laterally; sternites clearer yellow. Male hypopygium (Plate 2, fig. 33) with

the apex of the interbasal process, *i*, a tonglike structure, the lateral arm being a curved spine. Outer dististyle relatively slender, the vestiture of outer face consisting of abundant delicate setulæ, with a few longer setæ. Inner dististyle with apex dilated into a slight head, bearing one unusually long seta.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet, September 8, 1930 (*C. F. Clagg*); holotype, male; allotype, female, in copula.

There is a considerable group of species of *Polyphragma* in the Philippines having the head and mesonotum chiefly clear ashy gray, differing from one another by distinctions in the degree of development of the axillary lobe, the wing pattern, and slight details of structure of the male hypopygium. I have called this group of flies the *crenulata* group. The present fly falls in this division and seems closest to *E.* (*P.*) *cinereinota* Alexander; which differs in the coloration of wing and body, as the blackened subterminal ring of the abdomen.

EPIPHRAGMA (POLYPHRAGMA) GRISEICAPILLA sp. nov. Plate 1, fig. 16; Plate 2, fig. 34.

Belongs to the *crenulata* group; general coloration of dorsum of head and mesonotum light ashy gray; antennal scape dark brown, the flagellar fusion segment light yellow; wings with the ground color brownish yellow, the costal region clearer yellow; a heavy brown pattern that is narrowly bordered by clear yellow; male hypopygium with the apex of the interbasal process expanded, the notch small, the lobes broadly flattened.

Male.—Length, about 7 millimeters; wing, 7.5.

Rostrum and palpi black. Antennæ with the scapal segments dark brown, sparsely pruinose; fusion segment yellow; remainder of flagellum black; verticils longer than the segments. Head light gray in front, behind and on sides more brownish, the center of the posterior vertex brownish black.

Mesonotum clear light gray, the suture medially more brightened; lateral portions of the præscutum broadly and abruptly orange yellow. Pleura yellow. Halteres obscure yellow, the knobs infuscated. Legs with the coxæ and trochanters yellow; remainder of legs yellow, the femora a trifle darker just before the tips, this coloration caused more especially by an increase in dark setæ; terminal tarsal segments only slightly darkened. Wings (Plate 1, fig. 16) with the ground color brownish yellow, the cells beyond the cord even more suffused; prearcular and costal regions clear yellow, beyond the end of Sc continued to

the wing tip as yellow spots in the outer ends of cells R_2, R_3, and R_4; darker brown areas at arculus; origin of Rs; cord; fork of R_{2+3+4}; outer end of cell 1st M_2; fork of M_{1+2}; supernumerary crossvein in cell Cu, and the marginal clouds, all these areas narrowly bordered by clearer yellow rings; veins dark brown, darker in the clouded areas. Axillary crenulation of moderate size only, about one-half as deep as in the corresponding sex of *crenulata* or *caninota*. No macrotrichia on Rs or R_{2+3+4}. Venation: m-cu nearly its own length beyond the fork of M.

Abdominal tergites yellowish brown, the sternites clearer yellow, with the incisures narrowly darkened; hypopygium brownish yellow. Male hypopygium (Plate 2, fig. 34) much as in *caninota*, but the interbasal process, *i*, differently constructed, the apical notch being very small and shallow, the lobes broadly flattened.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,000 feet, September 16, 1930 (*C. F. Clagg*); holotype, male.

Epiphragma (*Polyphragma*) *griseicapilla* is allied to *E.* (*P.*) *crenulata* Alexander and *E.* (*P.*) *caninota* sp. nov., in the general coloration and relatively deep crenulation of the wing axilla, differing in the wing pattern and details of structure of the hypopygium.

EPIPHRAGMA (POLYPHRAGMA) ANGUSTICRENULA sp. nov. Plate 1, fig. 17; Plate 2, fig. 35.

Belongs to the *crenulata* group; general coloration of head and mesonotum light ashy gray; wings with a yellowish brown ground color, the dark pattern but slightly evident against this ground and not margined with paler; axillary crenulation of wing very shallow; male hypopygium with the interbasal process bifid at tip, the lateral arm a slender curved spine.

Male.—Length, about 7.5 millimeters; wing, 8.2.

Rostrum and palpi black. Antennæ with the scape and fusion segment obscure brownish yellow; remainder of flagellum black; fusion segment oval, involving three segments; verticils of flagellum exceeding the segments in length. Dorsum of head on front and anterior vertex light gray, the posterior vertex dark reddish brown, more blackened medially.

Mesonotum above light gray, the lateral margins of the præscutum abruptly orange yellow. Pleura obscure yellow, the dorsopleural region slightly darkened. Halteres dusky, the knobs infuscated. Legs with the coxæ and trochanters yellow; remainder of legs yellow, the terminal tarsal segments darkened.

Wings (Plate 1, fig. 17) with a yellowish brown suffusion, the prearcular and costal regions more yellowish, variegated by brown clouds at the veins; disk of wing with a diffuse brown pattern that is little conspicuous against the ground color, the areas not bordered by brighter; veins brown, yellow in the flavous costal interspaces. Axillary crenulation very shallow for this group of the subgenus, being about as wide as the prearcular cell immediately cephalad of it. Venation: Costal crossveins and spurs few, but strong and complete; m-cu about one-half its length beyond the fork of M.

Abdominal tergites light brown, bordered by dark brown laterally, the sternites yellow, with narrow darker margins. Male hypopygium (Plate 2, fig. 35) with the interbasal rods, *i*, bifid at tips, the lateral arm a slender curved spine, much as in *crenulata*, the mesal arm short and broadly truncated. Outer dististyle, *od*, relatively slender, the tip a chitinized, gently curved spine.

MINDANAO, Davao district, Mount Apo, Kidapawan trail to Lino Lake, altitude 7,000 to 8,000 feet, September 20, 1930 (*C. F. Clagg*) ; holotype, male.

Epiphragma (*Polyphragma*) *angusticrenula* differs from the other species of this group of the subgenus in the scarcely developed axillary crenulation of the wing, in conjunction with the other characters listed above.

ERIOPTERINI

TRENTEPOHLIA (PARAMONGOMA) CHIONOPODA sp. nov.

General coloration of thorax yellow; tips of femora white; tibiæ and tarsi white, the basal half of the former more-obscure whitish; wings grayish subhyaline, the prearcular and costal regions more yellowish.

Male.—Length, about 4 millimeters; wing, 4.2.

Rostrum and palpi brown. Antennæ with the scape dark brown, the flagellum somewhat lighter in color; flagellar verticils a little longer than the segments.

Thorax uniformly yellow. Halteres pale, the knobs weakly dusky. Legs with the coxæ and trochanters yellow; femora dirty white, the tips paling to clear white; tibiæ and tarsi white, the basal half of the former a trifle more obscure. Wings grayish subhyaline, the prearcular and costal regions light yellow; stigma small and very vague; veins pale brown, Sc light yellow. Venation: R_2 close to fork of R_{3+4}; R_3 less perpendicular and cell 1st M_2 smaller than in *banahaoensis;* cell 2d M_2 narrow.

Abdominal tergites brown medially, paler laterally; sternites light yellow, the outer segments more infuscated; hypopygium yellow.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet, at trap lantern, September 13, 1930 (*C. F. Clagg*); holotype, male.

Trentepohlia (*Paramongoma*) *chionopoda* is readily told from the other regional species by the coloration of the legs. The type of the subgenus *Paramongoma*, *albitarsis* (Doleschall), of Amboina, still seems to be known only from Doleschall's insufficient description and faulty figure, which, if only approximately correct, serve to separate the two species of crane flies.

TRENTEPOHLIA (PARAMONGOMA) PUSILLA Edwards.

Trentepohlia (*Paramongoma*) *pusilla* EDWARDS, Treubia 9 (1927) 356.

MINDANAO, Davao district, Lawa, at light, April, 1930 (*C. F. Clagg*). This species was described from Sebesi Island, near Krakatau, Java, where it was taken in April, 1921, by Dammerman.

The present specimen agrees almost exactly with Edwards's description. The allied *T.* (*P.*) *banahaoensis* Alexander (Luzon) has R_3 short and more nearly erect and the tips of the femora narrowly but conspicuously whitened.

TRENTEPOHLIA (MONGOMA) ÆQUIALBA sp. nov. Plate 1, fig. 18.

General coloration of mesonotum orange fulvous, patterned with black; femora light brown, the tips abruptly snowy white, the amount subequal on all legs; bases and tips of tibiæ whitened; wings with cells C and Sc strongly blackened, the prearcular region pale; abdominal tergites yellow, with a broad black dorsomedian stripe.

Male.—Length, about 14 to 16 millimeters; wing, 8.2 to 8.6.

Female.—Length, about 14 millimeters; wing, 9.

Rostrum and labial palpi obscure yellow; maxillary palpi black. Antennæ with the scapal segments brown, the flagellum black; flagellar segments long-cylindrical, with verticils that are subequal to the segments. Head fulvous orange, the vertex carinate medially.

Mesonotal præscutum orange fulvous, narrowly darkened laterally; centers of scutal lobes darkened; scutellum testaceous brown, darker brown caudally; postnotal mediotergite black

posteriorly and on sides, a little paler medially in front. Pleura chiefly orange yellow, the ventral pleurites slightly white pruinose; in cases the pleurotergite a little darkened posteriorly. Halteres blackened, the base of the stem restrictedly yellow. Legs with the coxæ and trochanters orange yellow; femora light brown, darkened outwardly, the tips abruptly snowy white, the amount subequal on all legs; tibiæ dark brown, the bases narrowly, the tips more broadly whitened; tarsi white, the terminal segment a little darkened; femora with short black setæ distributed over the entire length, with two or three longer black setæ at apex. Wings (Plate 1, fig. 18) narrow, cells C and Sc strongly blackened, confluent with the slightly darker stigma; wing apex narrowly infuscated; vague and narrow, scarcely evident dark seams on posterior cord; cell Cu and a spot between anal veins at point of divergence dark brown; prearcular region pale; veins black, the outer branches of M paler. Venation: R_2 about two-thirds to three-fourths its length before fork of R_{3+4}; veins R_3 and R_4 very strongly divergent; m-cu at or shortly before fork of M; fusion of Cu_1 and 1st A very slight to punctiform.

Abdominal tergites yellow laterally, with a broad black dorsomedian stripe; sternites more extensively yellow, the subcaudal margins narrowly darkened; extreme apices of segments silvery; subterminal segments and hypopygium blackened.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet, September 14, 1930; Galog River trail, altitude 5,000 to 6,000 feet, September 12, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 2 males.

The present species, and the two next defined, are all allied to *T.* (*M.*) *luzonensis* Edwards, from which they may be separated by the following key:

1. Tibiæ of all legs approximately alike in color .... 2.
   Tips of fore tibiæ broadly blackened, of posterior tibiæ even more broadly snowy white .... *T.* (*M.*) *luzonensis* Edwards.
2. Tips of femora and tibiæ snowy white .... *T.* (*M.*) *æquialba* sp. nov.
   Tips of femora and tibiæ blackened .... 3.
3. Mesonotal præscutum polished black, the humeral region yellow; a dark area on anepisternum; abdominal tergites blackened.
   T. (*M.*) *æquinigra* sp. nov.
   Mesonotal præscutum yellow, in cases restrictedly darkened at suture; pleura uniformly pale; abdominal tergites yellow with a narrow, more or less interrupted, dorsomedian black stripe.
   T. (*M.*) *majuscula* sp. nov.

TRENTEPOHLIA (MONGOMA) ÆQUINIGRA sp. nov. Plate 1, fig. 19.

General coloration of mesonotum polished black, the humeral region of the præscutum extensively yellow; pleura yellow, the dorsal anepisternum darkened; femora yellow, the tips of all narrowly but conspicuously blackened, the amount subequal on all legs; fore femora (male) broadly darkened on central portion; wings narrow, whitish, the costal border light yellow; wing tip narrowly darkened; abdominal tergites and a subterminal ring black, the sternites light yellow.

Male.—Length, about 13 millimeters; wing, 8.5 by 1.6.

Female.—Length, about 10 to 13 millimeters; wing, 7.2 by 1.5 to 9 by 1.75.

Rostrum and palpi brownish black. Antennæ with the scapal segments black; flagellum broken. Head brownish gray, clearer gray in front, the vertex carinate.

Pronotum obscure yellow. Mesonotal præscutum polished yellow, the lateral margins as far cephalad as the pseudosutural foveæ, together with a median line almost to the cephalic margin, blackened, leaving the humeral region extensively of the ground color; posterior sclerites of mesonotum chiefly blackened, the median area of the scutum a little brighter. Pleura abruptly yellow, with a large dark area on the dorsal anepisternum. Halteres brownish black, the base of the stem brightened. Legs with the coxæ and trochanters yellow; femora yellow, the tips of all legs somewhat narrowly but conspicuously blackened, the amount equal on all legs; in male, the general coloration of the fore femora is darker brown in the central portion, the tips again dark brown as described; tibiæ obscure yellow, the tips blackened; tarsi yellow; all femora with small scattered black setæ distributed over the entire length. Wings (Plate 1, fig. 19) narrow, whitish, the prearcular and costal regions light yellow; wing apex narrowly darkened; stigma small, dark brown; vague, scarcely evident dark seams along cord, the veins of the radial field, vein Cu_1, and a spot between the anal veins at point of divergence; veins dark brown, yellow in the flavous areas. Venation: R_2 about one-half its length before the fork of R_{3+4}; inner ends of cells R_5 and M_3 nearly in alignment; m-cu shortly before the fork of M; apical fusion of Cu_1 and 1st A punctiform.

Abdominal tergites black, the sternites abruptly orange yellow; a conspicuous subterminal black ring; female genitalia yellow horn color; male hypopygium chiefly darkened.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet, September 5, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratype, female.

The paratype is much smaller than the other types, as shown by the measurements. By my key to the Philippine species of *Trentepohlia* [2] the present species runs to couplet 10, disagreeing with both included species in the venation and wing pattern. The fly is most nearly related to *T.* (*M.*) *luzonensis* Edwards and allied species that have been discussed and keyed under the description of *T.* (*M.*) *æquialba* sp. nov.

TRENTEPOHLIA (MONGOMA) MAJUSCULA sp. nov. Plate 1, fig. 20.

Male.—Length, about 15 to 16 millimeters; wing, 10 to 10.5.

Female.—Length, about 16 to 16.5 millimeters; wing, 11.3 to 11.5.

Closely allied to *T.* (*M.*) *æquinigra* sp. nov., differing especially in the larger size and details of coloration.

Mesonotal præscutum rich fulvous orange, most intense medially, in cases entirely clear, in other specimens (including the holotype) narrowly blackened on either side at the suture; scutum with an irregular brown area on either lobe; scutellum chiefly testaceous yellow; postnotal mediotergite with the central portion yellow, the posterior margins darkened, the lateral portions again brightened. Pleura yellow to orange yellow. Halteres yellow, the knobs dark brown. Legs long and powerful; coxæ and trochanters concolorous with the pleura; femora chiefly light brown, the bases narrowly more yellowish, the tips narrowly blackened, the amount of the latter subequal on all legs; tibiæ brown, the tips broadly blackened; basitarsi black, the outer segments paling to brown; femora with scattered black setæ scattered over the entire length; a group of slightly longer and more erect setæ at base of posterior tibiæ. Wings (Plate 1, fig. 20) narrow, whitish, the prearcular and costal regions yellow; stigma small, dark brown; wing tip very narrowly infumed; Cu, the cord and veins of the radial field narrowly and vaguely seamed with darker; the usual small dark spot between anal veins present; veins black, C, Sc, and R more yellowish. Venation: Veins R_3 and R_4 strongly divergent; inner end of cell M_3 lying slightly proximad of cell R_5, the basal section of M_3 being angulated; m-cu at or close to the fork of M; apical fusion of Cu_1 and 1st A punctiform.

[2] Philip. Journ. Sci. 43 (1930) 297–298.

Abdominal tergites chiefly yellow, with a narrow, more or less broken, black longitudinal stripe; sternites uniformly yellow; subterminal segments and male hypopygium black. Ovipositor with the bases and valves yellowish horn color.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet; Seliban River, 7,000 feet; Galog River trail, 5,000 to 6,000 feet, September 10 to 12, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 1 male, 1 female.

The relationships are shown by the key to the Philippine species of *Trentepohlia* allied to *luzonensis*, as given under the definition of *T.* (*M.*) *æquialba* sp. nov.

TRENTEPOHLIA (TRENTEPOHLIA) LÆTIPENNIS sp. nov. Plate 1, fig. 21.

Rostrum and palpi black; antennæ with the basal segment of scape black, the flagellum pale; mesonotal præscutum and scutum obscure yellow, unmarked; posterior sclerites of mesonotum brown; pleura blackened, with a more or less distinct longitudinal pale stripe on dorsal sternopleurite; halteres black, the extreme base of the stem yellow; legs yellow; wings whitish, with a heavy dark brown pattern arranged as in the *ornatipennis* group; vein R_3 straight to slightly concave, the cell pointed at base; basal abdominal segments reddish yellow, the remainder blackened.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Female.—Length, about 5.5 to 6 millimeters; wing, 5 to 5.5.

Rostrum and palpi black. Antennæ with the basal segment of scape black, the pedicel and flagellum pale brownish yellow, more darkened outwardly; antennæ (male) relatively elongate, if bent backward extending almost to the wing root; flagellar segments long-cylindrical, the verticils shorter than the segments. Head brownish gray.

Mesonotal præscutum and scutum obscure yellow, the scutellum and postnotal mediotergite more infuscated. Pleura dark brown, with a more or less distinct paler longitudinal stripe on the dorsal sternopleurite. Halteres black, the extreme base of the stem yellow. Legs with the coxæ blackened; trochanters obscure yellow; remainder of legs yellow. Wings (Plate 1, fig. 21) whitish, with a heavy dark brown pattern, arranged on the plan of *ornatipennis* and allies; very heavy brown areas at the wing base; at mid-length of wing, sending extensions to vein M at origin of Rs and to the fork of Rs along the anterior cord; cells beyond the cord chiefly darkened, variegated by three white marginal areas in ends of cells R_2, R_3, and $R_4 + R_5$; cubital and

anal cells chiefly clear; veins Cu and m-cu seamed with brown; outer portion of cell 1st A extensively clouded with gray; veins pale, dark in the infuscated areas. Venation: Rs a trifle longer than R_{2+3+4}; vein R_3 straight or very gently concave, the inner end of the cell thus pointed; second section of M and $R_5 + M_{1+2}$ subequal and both about equal to the basal section of M_{1+2}; apical fusion of Cu_1 and 1st A slight.

Abdomen with the basal four segments reddish yellow, the remainder of the abdomen, including the hypopygium and ovipositor, black; in female, the lateral margins of the basal segments more or less darkened.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet, September 16 to 26, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 1 male, 2 females.

Trentepohlia (*Trentepohlia*) *lætipennis* is closely allied to species such as *T.* (*T.*) *ornatipennis* Brunetti (southwest India), *T.* (*T.*) *festivipennis* Edwards (Perak), and *T.* (*T.*) *venustipennis* Edwards (Borneo). It differs in the coloration of the body and the details of wing pattern and venation, falling closest to *ornatipennis* in the wing pattern but differing therefrom in the venation of the radial field and coloration of the body. In the present species, and very possibly in the other species of the group, the tip of R_{1+2} is atrophied.

TRENTEPOHLIA (ANCHIMONGOMA) APOICOLA sp. nov. Plate 1, fig. 22.

Head dark gray; general coloration of mesonotum dark brown, the humeral region extensively obscure yellow; pleura yellow, the ventral sternopleurite infuscated; tibiæ with the central half to three-fifths blackened.

Male.—Length, about 7 to 8.5 millimeters; wing, 7 to 8.

Rostrum dark, the labial palpi yellow; maxillary palpi black. Antennæ black throughout; flagellar segments with verticils that exceed the segments. Head dark gray.

Mesonotal præscutum medially dark brown to black, more intense in front, the humeral region extensively obscure yellow; posterior sclerites of mesonotum chiefly darkened, the scutellum obscure yellow. Pleura obscure yellow, the ventral sternopleurite infuscated. Halteres brownish black, the base of the stem restrictedly obscure yellow. Legs with the coxæ and trochanters yellow; femora black, the tips broadly and conspicuously snowy white, the amount subequal on all the legs; tibiæ black, the central portion blackened, most extensively on the posterior legs where about three-fifths of the segment is included; tarsi white.

Wings (Plate 1, fig. 22) grayish, cells C, Sc, and the apex a trifle darker; veins dark brown, those of the medial field paler. Venation: Sc_1 ending opposite the cephalic end of R_2, Sc_2 opposite the fork of Rs; cell Cu widely open at margin.

Abdomen dark brown, the basal sternites more yellowish; hypopygium black.

MINDANAO, Davao district, Mount Apo, altitude 6,000 to 8,000 feet, August 30 to September 22, 1930 (*C. F. Clagg*); holotype, male; paratypes, several males.

Trentepohlia (*Anchimongoma*) *apoicola* is very close to *T.* (*A.*) *niveipes* Edwards (Java), differing only in the details of coloration of the body and the slightly increased amount of black on the posterior tibiæ.

ILLUSTRATIONS

[Legend: *a*, ædeagus; *b*, basistyle; *d*, dististyle; *g*; gonapophysis; *i*, interbasal process; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *t*, tergite.]

PLATE 1

FIG. 1. *Limonia (Laosa) manobo* sp. nov., wing.
2. *Limonia (Limonia) bilan* sp. nov., wing.
3. *Limonia (Limonia) atroaurata* sp. nov., wing.
4. *Limonia (Limonia) bagobo* sp. nov., wing.
5. *Limonia (Limonia) subpacata* sp. nov., wing.
6. *Limonia (Limonia) subprolixa* sp. nov., wing.
7. *Helius (Helius) procerus* sp. nov., wing.
8. *Helius (Helius) apoensis* sp. nov., wing.
9. *Thaumastoptera (Thaumastoptera) maculivena* sp. nov., wing.
10. *Adelphomyia apoana* sp. nov., wing.
11. *Adelphomyia paucisetosa* sp. nov., wing.
12. *Epiphragma (Polyphragma) fuscofasciata* sp. nov., wing.
13. *Epiphragma (Polyphragma) nigrotibiata* sp. nov., wing.
14. *Epiphragma (Polyphragma) apoensis* sp. nov., wing.
15. *Epiphragma (Polyphragma) caninota* sp. nov., wing.
16. *Epiphragma (Polyphragma) griseicapilla* sp. nov., wing.
17. *Epiphragma (Polyphragma) angusticrenula* sp. nov., wing.
18. *Trentepohlia (Mongoma) æquialba* sp. nov., wing.
19. *Trentepohlia (Mongoma) æquinigra* sp. nov., wing.
20. *Trentepohlia (Mongoma) majuscula* sp. nov., wing
21. *Trentepohlia (Trentepohlia) lætipennis* sp. nov., wing.
22. *Trentepohlia (Anchimongoma) apoicola* sp. nov., wing.

PLATE 2

FIG. 23. *Limonia (Limonia) bagobo* sp. nov., male hypopygium.
24. *Limonia (Limonia) subpacata* sp. nov., male hypopygium.
25. *Limonia (Limonia) subprolixa* sp. nov., male hypopygium.
26. *Helius (Helius) procerus* sp. nov., male hypopygium.
27. *Thaumastoptera (Thaumastoptera) maculivena* sp. nov., male hypopygium.
28. *Adelphomyia paucisetosa* sp. nov., male hypopygium.
29. *Epiphragma (Polyphragma) latitergata* sp. nov., male hypopygium.
30. *Epiphragma (Polyphragma) nigrotibiata* sp. nov., male hypopygium.
31. *Epiphragma (Polyphragma) apoensis* sp. nov., male hypopygium.
32. *Epiphragma (Polyphragma) hastata* sp. nov., male hypopygium.
33. *Epiphragma (Polyphragma) caninota* sp. nov., male hypopygium.
34. *Epiphragma (Polyphragma) griseicapilla* sp. nov., male hypopygium.
35. *Epiphragma (Polyphragma) angusticrenula* sp. nov., male hypopygium.

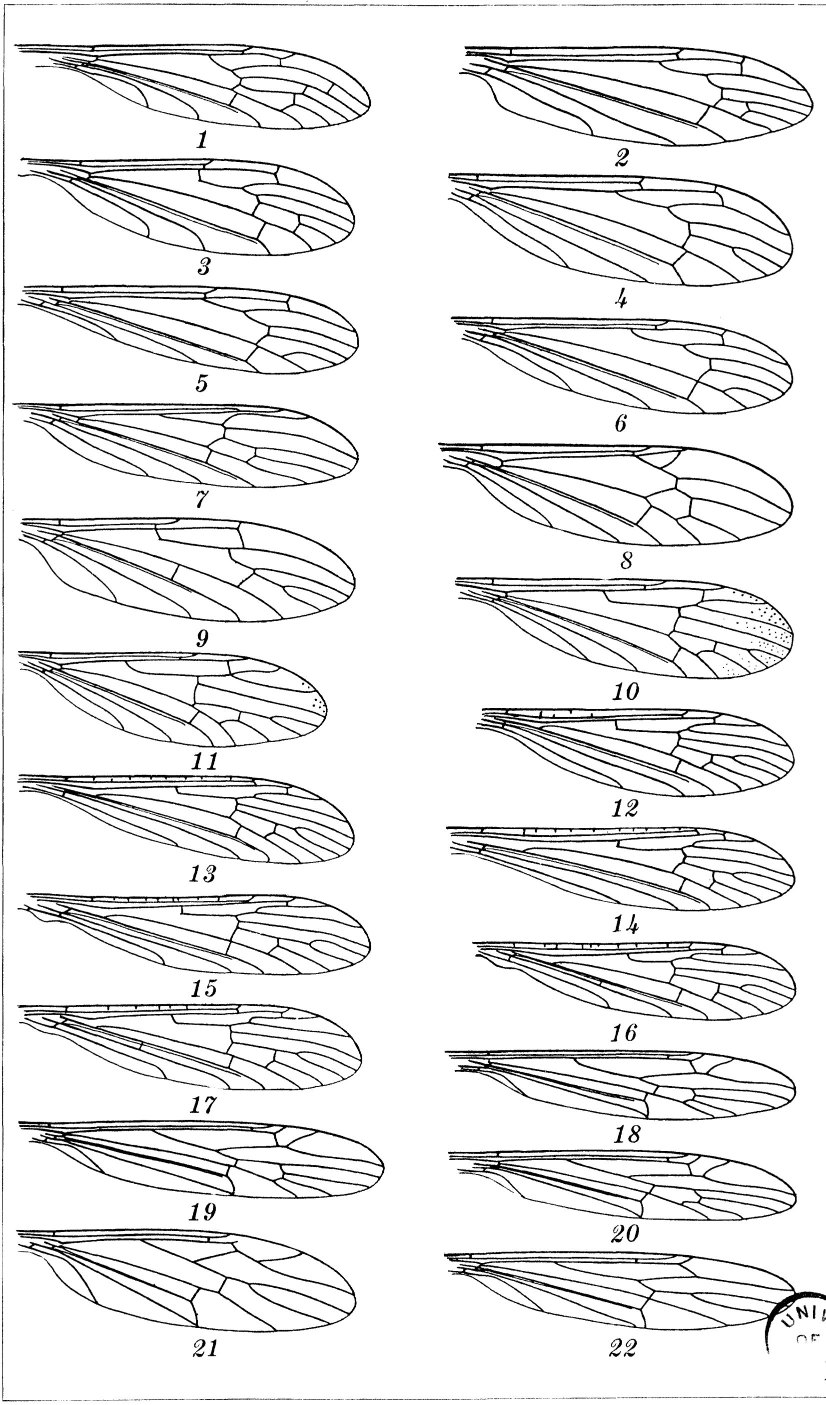

PLATE 1.

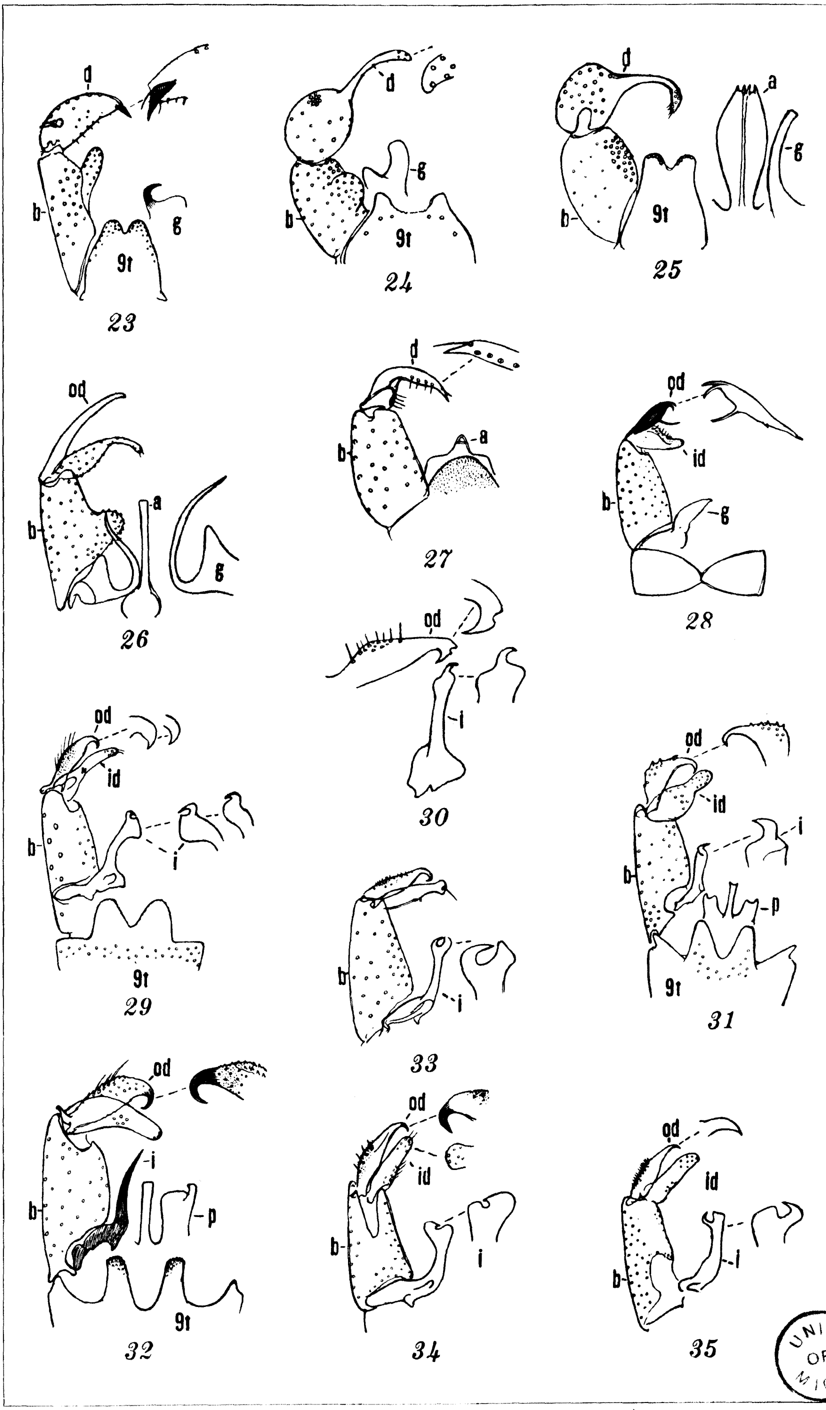

PLATE 2.

SECOND SUPPLEMENT TO THE LIST OF THE LOWER FUNGI OF THE PHILIPPINE ISLANDS [1]

A BIBLIOGRAPHIC LIST CHRONOLOGICALLY ARRANGED, AND WITH LOCALITIES AND HOSTS

By C. F. BAKER

Late Dean of the College of Agriculture, Los Baños, Philippine Islands

Edited by F. L. STEVENS

Charles Fuller Baker Memorial Professor (1930–1931) of Plant Pathology

UREDINALES

PUCCINIACEÆ

HEMILEIA CANTHII Berk. and Br.

On *Plectronia*. BAKER, Philip. Agr. & For. **3** (1914) 160; Philip. Journn. Sci. **13** (1918) 379.
On *Plectronia horrida*. Ann. Myc. **26** (1928) 419.

HEMILEIA VASTATRIX Berk. and Br.

On *Coffea arabica*. BAKER, Philip. Agr. & For. **3** (1914) 160; Ann. Myc. **15** (1917) 175; Philip. Journ. Sci. **13** (1918) 379; Ann. Myc. **26** (1928) 419; Philip. Agr. **17** (1928) 45.
On *Coffea* spp. Philip. Agr. & For. **6** (1917) 251; Phytopath. **9** (1919) 122; Philip. Agr. **15** (1926) 125; Philip. Agr. Rev. **19** (1926) 252.

[1] Contribution from the Experiment Station of the College of Agriculture, Los Baños, Laguna, Philippine Islands. Published with the approval of the Director of the Experiment Station.

The editor has chosen to print this article as nearly as possible as it was left in manuscript by Dean Baker, with the exception of a considerable number of added references, rather than to make changes of which he might not have approved. The arrangement followed is essentially that of the two earlier Baker lists. Some of the references give no internal evidence that the fungi in question occur in the Philippines, but the fact that they were placed in Dean Baker's manuscript makes it presumptive that they do so occur. Dean Baker's work on the manuscript ceased about 1921.

For the convenience of those who will use this list the editor will issue later a combined index to the fungi of the Philippine Islands.

Dr. G. O. Ocfemia, of the Department of Plant Pathology of the College of Agriculture, at Los Baños, rendered valuable assistance in the gathering of materials for this manuscript.

HAMASPORA ACUTISSIMA Syd.

On *Rubus moluccanus.* Ann. Myc. 15 (1917) 174; 26 (1928) 418.

PUCCINIA CITRATA Syd.

On *Andropogon citratus.* BAKER, Philip. Agr. & For. 3 (1914) 158; Philip. Journ. Sci. 13 (1918) 379; Ann. Myc. 21 (1923) 93.

PUCCINIA CONGESTA Berk. and Br.

On *Polygonum chinensis.* Ann. Myc. 15 (1917) 173.
On *Polygonum tomentosum.* Ann. Myc. 26 (1928) 416.

PUCCINIA ENGLERIANA P. Henn.

On *Tabernaemontana campanulata.* Ann. Myc. 15 (1917) 173.

PUCCINIA EREBIA Syd.

On *Clerodendron minahassae.* Ann. Myc. 15 (1917) 172.
On *Clerodendron inermis.* Ann. Myc. 26 (1928) 416.

PUCCINIA HETEROSPORA Berk. and Curt.

On *Sida javensis.* Philip. Journ. Sci. 13 (1918) 379; Ann. Myc. 26 (1928) 416.

PUCCINIA KUEHNII (Krueg.) Butl. [Uredo kuehnii (Krueg.) Wakk. and Went.]

On *Saccharum officinarum.* BAKER, Philip. Agr. & For. 3 (1914) 164; Philip. Agr. Rev. 11 (1918) 275; REINKING, Philip. Journ. Sci. 15 (1918) 169; Phytopath. 9 (1919) 135; Philip. Agr. Rev. 14 (1921) 430; Ann. Myc. 26 (1928) 417.

PUCCINIA MERRILLII P. Henn.

On *Smilax bracteata.* Ann. Myc. 15 (1917) 173.
On *Smilax reticulata.* Leafl. Philip. Bot. 9 (1925) 3133.

PUCCINIA PAULLULA Syd.

On *Amorphophallus campanulatus.* Ann. Myc. 15 (1917) 173; 26 (1928) 417.

PUCCINIA PHILIPPINENSIS Syd.

On *Cyperus compressus.* Ann. Myc. 15 (1917) 173.

PUCCINIA PURPUREA Cke.

On *Andropogon sorghum* (*Sorghum vulgare, Holcus sorghum*). SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 16—Los Baños (*Baker 3747*); BAKER, Philip. Journ. Sci. 5 (1916) 77; Philip. Agr. & For. 5 (1916) 77; Ann. Myc. 15 (1917) 174; REINKING, Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 137; Ann. Myc. 26 (1928) 417.
On *Andropogon halepensis.* Ann. Myc. 21 (1923) 93.

PUCCINIA THWAITESII Berk.

On *Justicia gendarussa.* BAKER, Philip. Agr. & For. 3 (1914) 161; Ann. Myc. 15 (1917) 173; Philip. Journ. Sci. 13 (1918) 379; Ann. Myc. 26 (1928) 417.

PUCCINIOSTELE CLARKIANA (Barcl.) Diet.

On *Astilbe philippinensis.* Ann. Myc. 15 (1917) 175.

SPHAEROPHRAGMIUM LUZONICUM Yates.

On *Albizzia procera.* Philip. Journ. Sci. **13** (1918) 379; Ann. Myc. **20** (1922) 66; **26** (1928) 418.

UROMYCES APPENDICULATUS (Pers.) Lk.

On *Vigna* spp. Philip. Agr. & For. **4** (1914) 164; **5** (1916) 77; Ann. Myc. **21** (1923) 93.

On *Phaseolus* spp. REINKING, Philip. Journ. Sci. **13** (1918) 169; Philip. Agr. **10** (1922) 349.

On *Phaseolus mungo.* Phytopath. **9** (1919) 132.

UROMYCES DEERINGIAE Syd.

On *Deeringia baccata.* Ann. Myc. **26** (1928) 414.

UROMYCES LINEARIS Berk. and Br.

On *Panicum.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 16—Los Baños (*Baker 3736*).

On *Panicum repens.* Ann. Myc. **15** (1917) 172; **26** (1928) 415.

UROMYCES MUCUNAE Rabh.

On *Mucuna deeringiana* (*Stizolobium deeringianum*). BAKER, Philip. Agr. & For. **3** (1914) 164; Philip. Journ. Sci. **13** (1918) 168.

On *Mucuna cochinchinensis* (*M. nivea, Stizolobium niveum*). Phytopath. **9** (1919) 132; Ann. Myc. **26** (1928) 415.

UROMYCES SOJAE Syd.

On *Glycine max* (*G. hispida, G. sojae*). BAKER, Philip. Agr. & For. **3** (1914) 161; Ann. Myc. **15** (1917) 172; Philip. Journ. Sci. **13** (1918) 167; Phytopath. **9** (1919) 126.

UROMYCES WEDELIAE P. Henn.

SACCARDO, Syll. Fung. **17** (1895) 245; HENNINGS, Hedwigia (1904) 150—Japan; BACCARINI, Ann. Bot. **4** (1907) tab. 10, f. 9; SYDOW, Monogr. Ured. **2** (1907) 15; Ann. Myc. **15** (1917) 172.

COLEOSPORIACEÆ

COLEOSPORIUM EXACI Syd.

On *Exacum chironioides.* Ann. Myc. **26** (1928) 425.

COLEOSPORIUM KNOXIAE Syd.

On *Knoxia corymbosa.* Ann. Myc. **26** (1928) 425.

COLEOSPORIUM MERRILLII P. Henn.

On Orchidaceae. BAKER, Philip. Agr. & For. **3** (1914) 163.

SCHROETERIASTER CINGENS Syd.

On *Bridelia glabrifolia.* Ann Myc. **26** (1928) 423.

MELAMPSORACEÆ

KUEHNEOLA DESMIUM (Berk. and Br.) Arth.

On *Gossypium* spp. BAKER, Philip. Agr. & For. **3** (1914) 161; Philip. Journ. Sci. **13** (1918) 167.

KUEHNEOLA FICI (Cast.) Butl.

On *Ficus carica*. BAKER, Philip. Agr. & For. **3** (1914) 161; Philip. Journ. Sci. **13** (1918) 167; Phytopath. **9** (1919) 124, 128.

On *Morus alba* (*M. albus*). BAKER, Philip. Agr. & For. **3** (1914) 162; Ann. Myc. **15** (1917) 175.

KUEHNEOLA FICI (Cast.) Butl. f. **MORICOLA** P. Henn.

On *Morus alba* (*M. albus*). SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 16—Los Baños (*Baker 3735*); Syll. Fung. **17** (1916) 451 (*Uredo moricola*); Syll. Fung. **9** (1916) 334 (*Uredo mori*); Philip. Journ. Sci. **13** (1918) 168.

PHAKOSPORA PACHYRHIZI Syd.

On *Pachyrrhizus erosus* (*P. angulatus, Carcara erosa*). Philip. Agr. & For. **4** (1914) 163; Ann. Myc. **15** (1917) 175; Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 131; Ann. Myc. **26** (1928) 422.

PHAKOSPORA PHYLLANTHI Diet.

On *Phyllanthus* sp. Ann. Myc. **15** (1917) 175.

On *Phyllanthus niruri*. Ann. Myc. **26** (1928) 423.

UREDINALES IMPERFECTI

AECIDIUM ALCHORNEAE Sacc.

On *Alchornea rugosa*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 17—Mount Maquiling (*Baker 3786*).

AECIDIUM BANOSENSE Syd.

On *Vernonia vidali*. Ann. Myc. **26** (1928) 426.

AECIDIUM BLUMEAE P. Henn.

On *Blumea balsamifera*. Ann. Myc. **15** (1917) 176; **26** (1928) 426.

AECIDIUM CLERODENDRI P. Henn.

On *Clerodendron fragrans*. Ann. Myc. **15** (1917) 176.

AECIDIUM ELAEAGNI-LATIFOLIAE Petch.

On *Elaeagnus philippinensis*. Ann. Myc. **26** (1928) 426.

AECIDIUM FLAVIDUM Berk. and Br.

On *Pavetta indica*. Leafl. Philip. Bot. **9** (1925) 3133.

AECIDIUM KAERNBACHII P. Henn.

On *Ipomoea pes-caprae*. Ann. Myc. **15** (1917) 176.

On *Lepistemon flavescens*. Philip. Journ. Sci. **13** (1918) 378; Ann. Myc. **26** (1928) 427.

AECIDIUM LAGUNENSE Syd.

On *Gymnema tingentis*. Ann. Myc. **26** (1928) 427.

AECIDIUM LUZONIENSE P. Henn.

On *Phyllanthus* sp. Ann. Myc. **26** (1928) 427.

AECIDIUM NUMMULARE Berk.

On *Ceropegia* sp. Ann. Myc. **26** (1928) 427.

AECIDIUM PAEDERIAE Diet.

On *Paederia foetida* (*P. tomentosa*). Ann. Myc. 15 (1917) 176; 26 (1928) 427.

AECIDIUM RHYTISMOIDEUM Berk. and Br.

On *Diospyros discolor*. Philip. Journ. Sci. 13 (1918) 379.

AECIDIUM UVARIAE-RUFAE P. Henn.

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UREDO ARTHRAXONIS-CILLARIS P. Henn.

On *Arthraxonis* sp. Ann. Myc. 15 (1917) 177.
On *Anthraxonis quartiniani*. Ann. Myc. 26 (1928) 428.

UREDO CLAOXYLI Sacc.

On *Claoxylum* sp. SACCARDO, Ann. Myc. 13 (1915) 126—Mount Maquiling (*Baker 2787*).

UREDO DAVAOENSIS Syd.

On *Cyanotis axillaris*. Ann. Myc. 26 (1928) 428.

UREDO DESMIUM (Berk. and Br.) Petch.

On *Gossypium* sp. Philip. Journ. Sci. 13 (1918) 167; Phytopath. 9 (1919) 126.

UREDO DIOSCOREAE (Berk. and Br.) Petch.

On *Dioscorea esculenta*. Philip. Journ. Sci. 13 (1918) 167; Phytopath. 9 (1919) 124.

UREDO DIOSCOREAE-ALATAE Rac.

On *Dioscorea alata*. BAKER, Philip. Agr. & For. 3 (1914) 161; Ann. Myc. 15 (1917) 177.
On *Dioscorea esculenta*. Philip. Journ. Sci. 13 (1918) 167.
On *Dioscorea*. Phytopath. 9 (1919) 124.

UREDO ERYTHRINAE P. Henn.

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UREDO FICI Cast.

On *Ficus carica* Linn. Philip. Journ. Sci. 13 (1918) 167.

UREDO MANILENSIS Syd.

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UREDO OCHRACEA Diet.

On *Commelina*. DIETEL, Hedwigia 35 (1897)—Brazil; SACCARDO and SYDOW, Syll. Fung. 14 (1899) 403.

UREDO OPERCULINAE Syd.

On *Operculina turpethum*. Ann. Myc. 15 (1917) 177; 26 (1928) 429.

UREDO PREMNAE Koord.

On *Premna vestita.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 16—Los Baños (*Baker 3828*).
On *Premna cumingiana.* Ann. Myc. **15** (1917) 177.

UREDO VIGNAE Bres.

On *Vigna* spp. BAKER, Philip. Agr. & For. **3** (1914) 164 [*Uromyces appendiculatus* (Pers.) Lk.]; BAKER, Philip. Agr. & For. **5** (1916) 77; Philip. Journ. Sci. **13** (1918) 170; Phytopath. **9** (1919) 139.
On *Phaseolus mungo.* Ann. Myc. **15** (1917) 177.
On *Glycine hispida* (*G. max, G. sojae*). Ann. Myc. **21** (1923) 94.

USTILAGINALES

USTILAGINACEÆ

CINTRACTIA AXICOLA (Berk.) Cornu.

On *Fimbristylis diphylla.* Ann. Myc. **15** (1917) 178.

USTILAGO ANDROPOGONIS-ACICULATI Petch.

On *Andropogon aciculatus.* Ann. Myc. **26** (1928) 430.

USTILAGO FLAGELLATA Syd.

On *Rottboellia exaltata.* Ann. Myc. **15** (1917) 178; **26** (1928) 430.

USTILAGO ISACHNES Syd.

On *Isachne miliacea.* Ann. Myc. **15** (1917) 178; **26** (1928) 430.

USTILAGO MANILENSIS Syd.

On *Panicum indicum.* Ann. Myc. **15** (1917) 178.

USTILAGO SCITAMINEA (Rabh.) Syd. (Ustilago sacchari Rabh.)

On *Saccharum officinarum.* Philip. Agr. Rev. **1** (1908) 295; **2** (1909) 14; BAKER, Philip. Agr. & For. **3** (1914) 164; **5** (1916) 76; Philip. Journ. Sci. **13** (1918) 169; Philip. Agr. Rev. **11** (1918) 275; Phytopath. **9** (1919) 135; Philip. Agr. Rev. **14** (1921) 428; **18** (1925) 562.

USTILAGO SORGHI (Lk.) Pass.

On *Andropogon sorghum* (*Sorghum vulgare, Holcus sorghum*). Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 137.

USTILAGO TONGLINENSIS Tracy and Earle.

On *Ischaemum aristatum.* Ann. Myc. **15** (1917) 178; **26** (1928) 430.

TILLETIACEÆ

ENTYLOMA ORYZAE Syd.

On *Oryza sativa.* BAKER, Philip. Agr. & For. **4** (1914) 163; Philip. Journ. Sci. **13** (1918) 378; Phytopath. **9** (1919) 131.

PERISPORIALES

ERYSIPHACEÆ

PHYLLACTINIA SUFFULTA (Rebent.) Sacc.

On *Morus alba.* Philip. Agr. & For. **4** (1914) 162; Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 128.

PERISPORIACEÆ

ACTINODOTHIS PIPERIS Syd.

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BALLADYNA VELUTINA (Berk. and Curt.) v. Hoehnel.

On *Plectronia didyma*. Ann. Myc. 15 (1917) 180.

DIMERINA GRAFFII Syd.

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DIMERIUM TAYABENSE Yates.

On *Momordica* sp. Ann. Myc. 20 (1928) 69; Philip. Journ. Sci. 12 (1917) 362.

MELIOLA AFFINIS Syd.

On *Memecylon* sp. Philip. Journ. Sci. 12 (1917) 362.

MELIOLA ALIENA Syd.

On fallen branches. Ann. Myc. 15 (1917) 181.

MELIOLA ALSTONIAE Koord.

On *Alstonia scholaris*. Ann. Myc. 15 (1917) 181.
On *Alstonia*. Leafl. Philip. Bot. 9 (1925) 3133.

MELIOLA ARACHNOIDEA Speg.

On *Triumfetta* sp. Ann. Myc. 15 (1917) 182.

MELIOLA ARUNDINIS Pat.

On *Phragmites vulgaris*. Ann. Myc. 15 (1917) 182; Leafl. Philip. Bot. 9 (1925) 3133.
On *Saccharum officinarum*. Philip. Agr. & For. 5 (1916) 343; Philip. Agr. Rev. 11 (1918) 275; Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 136; Philip. Agr. Rev. 14 (1921) 431.

MELIOLA BAKERI Syd.

On *Tetrastigma* sp. Ann. Myc. 14 (1916) 355; 15 (1917) 182; Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA CALLICARPAE Syd.

On *Callicarpa cana*. Ann. Myc. 15 (1917) 182.
On *Callicarpa* sp. Philip. Journ. Sci. 13 (1918) 362.

MELIOLA CALLISTA Rehm.

On *Premna odorata*. Ann. Myc. 15 (1917) 183.

MELIOLA CITRICOLA Syd.

On *Citrus* sp. Ann. Myc. 15 (1917) 183; REINKING, Philip. Agr. 9 (1920) 138; Ann. Myc. 21 (1923) 96.

MELIOLA CLERODENDRICOLA P. Henn.

On *Clerodendron* sp. Philip. Journ. Sci. 13 (1918) 363.

MELIOLA COOKEANA Speg. var. SACCARDOI Syd.

On *Litsea mollis.* SYDOW, Ann. Myc. 170—Chile (1904); SACCARDO, Syll. Fung. 17 (1905) 546.
On *Litsea glutinosa.* Ann. Myc. 15 (1917) 184.

MELIOLA CYLINDROPHORA Rehm.

On *Guioa perrottetii.* Ann. Myc. 15 (1917) 184.
On *Itea macrophylla.* Ann. Myc. 21 (1923) 95.

MELIOLA DESMODII Karst. and Roum.

On *Desmodium pulchellum.* Ann. Myc. 15 (1917) 185.

MELIOLA DICHOTOMA Berk. and Cke.

On *Phragmitis karka.* Ann. Myc. 15 (1917) 185.

MELIOLA ELMERI Syd.

On *Pittosporum pentandrum.* Ann. Myc. 15 (1917) 185.
On *Pittosporum* sp. Ann. Myc. 21 (1923) 96.

MELIOLA GYMNOSPORIAE Syd.

On *Gymnospora spinosa.* Philip. Journ. Sci. 13 (1918) 363.

MELIOLA HEWITTIAE Rehm.

On *Hewittia sublobata.* Philip. Journ. Sci. 12 (1917) 362; Ann. Myc. 15 (1917) 186; 21 (1923) 96.

MELIOLA HYPTIDIS Syd.

On *Hyptis suaveolens.* Ann. Myc. 15 (1917) 186; Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA INTRICATA Syd.

On *Scirpus grossus.* Ann. Myc. 15 (1917) 186.

MELIOLA MACARANGAE Syd. (Meliola apayaoensis Yates.)

On *Macaranga tanarius.* Ann. Myc. 15 (1917) 188; Philip. Journ. Sci. 13 (1918) 364; Ann. Myc. 20 (1922) 67.

MELIOLA MANGIFERAE Earle.

On *Mangifera indica.* BAKER, Philip. Agr. & For. 4 (1914) 162; Ann. Myc. 15 (1917) 189; Philip. Journ. Sci. 13 (1918) 363; Phytopath. 9 (1919) 127; Ann. Myc. 21 (1923) 97.

MELIOLA MERREMIAE Rehm.

On *Merremia hederacea.* Ann. Myc. 15 (1917) 190.

MELIOLA MERRILLII Syd.

On *Cissus* sp. Ann. Myc. 15 (1917) 190.

MELIOLA MITRAGYNES Syd.

On *Mitragyne rotundifolia.* Philip. Journ. Sci. 13 (1918) 363.

MELIOLA PANICI Earle.

On *Rottboellia exaltata.* Ann. Myc. 26 (1928) 431.

MELIOLA PARENCHYMATICA Gaill.

On *Sapindus* sp. Ann. Myc. 15 (1917) 191.

MELIOLA PERPUSILLA Syd.

On *Tylophora perrottetii*. Ann. Myc. 15 (1917) 191.
On *Tylophora floribunda*. Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA PIPERINA Syd.

On *Piper* sp. Ann. Myc. 14 (1916) 358; 15 (1917) 191; Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA POLYTRICHA Kalch. and Cke.

On *Ardisia*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 17—Los Baños (*Baker 3832*).

MELIOLA QUADRISPINA Rac.

On *Merremia umbellata*. Ann. Myc. 15 (1917) 191.

MELIOLA SANDORICI Rehm.

On *Sandoricum koetjape*. Ann. Myc. 15 (1917) 192; Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA SIDAE Rehm.

On *Sida carpinifolia*. Ann. Myc. 15 (1917) 192.
On *Sida acuta*. Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA SUBSTENOSPORA v. Hoehn. f. **ROTTBOELLIAE** Rehm.

On *Rottboellia exaltata*. Leafl. Philip. Bot. 9 (1925) 3134.

MELIOLA TAMARINDI Syd.

On *Tamarindus indica*. Ann. Myc. 15 (1917) 192; Philip. Journ. Sci. 13 (1918) 363.

MELIOLA TELOSMAE Rehm.

On *Telosma* sp. Ann. Myc. 15 (1917) 192.

MELIOLA UNCARIAE Rehm.

On *Uncaria perrottetii*. Ann. Myc. 15 (1917) 193.

PARODIELLA GRAMMODES (Kze.) Cooke.

Australian Fungi (1892) 301.
On *Desmodium triflorum*. Philip. Journ. Sci. 13 (1918) 371.

CAPNODIACEÆ

AITHALODERMA CLAVATISPORUM Syd.

On *Psidium guajava*. BAKER, Philip. Agr. & For. 4 (1914) 163; Phytopath. 9 (1919) 133.
On *Antidesma bunius*. Philip. Journ. Sci. 12 (1917) 373.
On *Ixora* sp. Ann. Myc. 15 (1917) 179.
On *Chrysophyllum oliviformis*. Ann. Myc. 21 (1923) 97.

CAPNODIUM FOOTII Berk. and Desm.

On *Cocos nucifera*. BAKER, Philip. Agr. & For. 4 (1914) 160; Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 121.

FUMAGO VAGANS Pers.

On *Andropogon sorghum* (*Sorghum vulgare, Holcus sorghum*). Ann. Myc. 15 (1917) 264; Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 138.

LIMACINIA BISEPTATA Sacc.

On *Macaranga* sp. SACCARDO, Ann. Myc. 13 (1915) 127—Los Baños (*Baker 2583*).

LIMACINULA MALLOTI Rehm.

On *Mallotus philippinensis.* Philip. Agr. & For. 4 (1914) 164.

MICROXYPHIUM DUBIUM Sacc.

On *Pinanga.* SACCARDO, Ann. Myc. 13 (1915) 127—Los Baños (*Reyes*, comm. *Baker 81*).

HEMISPHAERIALES

MICROTHYRIACEÆ

ASTERINA BREYNIAE Syd. (Asterina breyniae Yates.)

On *Breynia cernua.* Ann. Myc. 15 (1917) 242; Philip. Journ. Sci. 12 (1917) 370; Ann. Myc. 20 (1922) 71.

ASTERINA CAPPARIDIS Syd. and Butl.

On *Capparis micracantha.* Philip. Journ. Sci. 12 (1917) 370; Ann. Myc. 26 (1928) 439.
On *Capparis horrida.* Ann. Myc. 15 (1917) 243.
On *Capparis irosinensis.* Leafl. Philip. Bot. 9 (1925) 3137.

ASTERINA CASSIAE Syd.

On *Phyllanthus reticulatus.* Ann. Myc. 15 (1917) 245.
On *Cuestis diffusa.* Ann. Myc. 21 (1923) 103.

ASTERINA COLLICULOSA Speg.

On *Eugenia jambolana.* Philip. Journ. Sci. 12 (1917) 370.

ASTERINA DECIPIENS Syd.

On *Champereia manillana.* Ann. Myc. 15 (1917) 245; Philip. Journ. Sci. 13 (1918) 372.

ASTERINA DILLENIAE Syd.

On *Dillenia philippinensis.* Ann. Myc. 15 (1917) 244.

ASTERINA ELMERI Syd.

On *Champereia manillana.* Philip. Journ. Sci. 12 (1917) 370; Ann. Myc. 21 (1923) 103.
On *Champereia cumingiana.* Ann. Myc. 15 (1917) 245.
On *Champereia* sp. Leafl. Philip. Bot. 9 (1925) 3137.

ASTERINA GMELINAE Sacc.

On *Gmelina.* SACCARDO, Nuovo Giorn. Bot. Ital. 23, (1916) 17—Los Baños (*Baker 3763*).

ASTERINA LAWSONIAE P. Henn. and Nym.

On *Lawsonia inermis*. BAKER, Philip. Agr. & For. 4 (1914) 162; Ann. Myc. 15 (1917) 244.

ASTERINA LAXIUSCULA Syd.

On *Sideroxylon* sp. Ann. Myc. 15 (1917) 244.

On *Sideroxylon ferrungineum*. Philip. Journ. Sci. 13 (1918) 372.

ASTERINA LOBATA Syd.

On unknown host. Ann. Myc. 15 (1917) 244.

ASTERINA OPPOSITA Syd.

On *Heynea sumatrana*. Ann. Myc. 15 (1917) 245.

ASTERINA PIPTURI Syd.

On *Pipturus arborescens*. Ann. Myc. 14 (1916) 366; 15 (1917) 245; Leafl. Philip. Bot. 9 (1925) 3137.

ASTERINA PUSILLA Syd.

On *Premna* sp. Ann. Myc. 15 (1917) 244.

ASTERINA SPONIAE Rac.

On *Trema orientalis*. Philip. Journ. Sci. 12 (1917) 370.

On *Trema amboinensis*. Ann. Myc. 15 (1917) 244.

On *Trema* sp. Ann. Myc. 21 (1923) 103; Leafl. Philip. Bot. 9 (1925) 3137.

MORENOELLA MEMECYLI Syd.

On *Memecylon lanceolatum*. Ann. Myc. 15 (1917) 251; Philip. Journ. Sci. 12 (1917) 372.

On *Memecylon subfurfuraceum*. Ann. Myc. 21 (1923) 104.

TRICHOTHYRIUM ORBICULARE Syd.

On *Meliola* sp. Ann. Myc. 15 (1917) 236.

On *Ficus ulmifolia*. Leafl. Philip. Bot. 9 (1925) 3136.

SEYNESIA ALSTONIAE Rehm.

On *Alstonia macrophylla*. Ann. Myc. 16 (1918) 221.

SEYNESIA IPOMOEAE Syd.

On *Merremia* sp. Ann. Myc. 15 (1917) 239.

ASTERINELLA CALAMI Syd.

On *Calamus* sp. Ann. Myc. 15 (1917) 248; Philip. Journ. Sci. 13 (1918) 375.

ASTERINELLA LUZONENSIS Syd.

On *Shorea* sp. Philip. Journ. Sci. 13 (1918) 376.

ASTERINELLA OBESA Syd.

On *Canarium* sp. Ann. Myc. 15 (1917) 247; 21 (1923) 104.

ASTERINELLA STUHLMANNI (Henn.) Theiss.

On *Ananas comosus* (*A. sativus, A. sativas, Ananassa sativa*). BAKER, Philip. Agr. & For. 5 (1916) 73—Los Baños; Ann. Myc. 15 (1917) 247; Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 115; Ann. Myc. 21 (1923) 104.

LEMBOSIA CONGREGATA Syd.

On *Rhododendron schadenbergii.* REHM, Leafl. Philip. Bot. 8 (1915) 2931—Mount Banahao (*A. S. Cruz,* comm. *Baker 2981*).

LEMBOSIA CRUSTACEA (Cke.) Theiss.

COOKE, Grevilea 14 (1915) 13 (*Asterina*); SACCARDO, Syll. Fung. 9 (1891) 380 (*Asterina*); THEISSEN, Ann. Myc. 11 (1891) 432; BAKER, Leafl. Philip. Bot. 6 (1914) 2137 (*Morenoella breviuscula*).

On *Rhododendron schadenbergii.* RHEM, Leafl. Philip. Bot. 8 (1915) 2931—Mount Banahao (*Catalan,* comm. *Baker 2921*).

On *Rhododendron* sp. Ann. Myc. 15 (1917) 249.

LEMBOSIA EUGENIAE Rehm.

On *Eugenia.* REHM, Leafl. Philip. Bot. 8 (1915) 2932—Hills back of Paete, Luzon (*Baker 3137a*).

On *Eugenia calubcub.* Ann. Myc. 15 (1917) 249.

LEMBOSIA JAVANICA (Pat.) Rac.

On *Nipa fruticans.* Philip. Agr. & For. 4 (1914) 163.

LEMBOSIA PANDANI (Rostr.) Theiss.

On *Pandanus.* ROSTRUP (*Asterina pandani*); THEISSEN, Ann. Myc. (1913) 457; Syll. Fung. 17 (1913) 881; REHM, Leafl. Philip. Bot. 8 (1915) 3932—Hills back of Paete (*Baker 3113b*).

On *Pandanus copelandi.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 23—Hills back of Paete (*Baker 3789*).

LEMBOSIA POTHOIDEI Rehm.

On *Pothoideum lobbianum.* Leafl. Philip. Bot. 9 (1925) 3137.

MERRILLIOPELTIS CALAMI P. Henn.

On *Calamus.* REHM, Leafl. Philip. Bot. 8 (1916) 2945—Mount Maquiling (*Baker 2739, 3189*); Philip. Journ. Sci. 12 (1917) 377.

MERRILLIOPELTIS DAEMONOROPSIS Syd.

On *Daemonorops.* REHM, Leafl. Philip. Bot. 8 (1916) 2945—Mount *Maquiling* (*Reyes,* comm. *Baker 3343*).

MERRILLIOPELTIS HOEHNELII Rehm.

On *Dinochloa* and *Arenga saccharifera.* REHM, Leafl. Philip. Bot. 8 (1916) 2945—Mount Maquiling (*Baker 2189*); Los Baños (*Reyes,* comm. *Baker 3371*).

TRICHOTHYRIACEÆ

THEISSEN, Beih. Bot. Centralbl. 32 (1914) 14.

GILLETIELLA LATEMACULANS Rehm.

On *Arenga saccharifera.* Philip. Agr. & For. 4 (1914) 158.

LORANTHOMYCES SORDIDULA (Lev.) v. Hoehn.

On *Loranthus haenkeani.* BAKER, Leafl. Philip. Bot. 6 (1914) 2115; 7 (1914) 2468; Ann. Myc. 15 (1917) 236.

On *Loranthus* sp. Ann. Myc. 21 (1923) 99.

HEMISPHAERIACEÆ

MICROPELTIS AERUGINASCENS Rehm.

On *Rourea erecta.* Ann. Myc. **15** (1917) 231.

DICTYOTHYRIELLA MUCOSA Syd. (Micropeltis mucosa Syd.)

On *Coffea excelsa.* BAKER, Philip. Agr. & For. **5** (1916) 75—Los Baños; Ann. Myc. **14** (1916) 364; Philip. Journ. Sci. **13** (1918) 167; Phytopath. **9** (1919) 122.

MICROTHYRIELLA PHILIPPINENSIS Syd.

On *Lepisanthes schizolepis, Evonymus japonicus, Bauhinia cumingiana.* Ann. Myc. **15** (1917) 235.

MICROTHYRIELLA LATEMACULANS (Rehm) Theiss and Syd.

BAKER, Leafl. Philip. Bot. **7** (1914) 2443 (*Gillettiella*); BAKER, Philip. Agr. & For. **3** (1914) 158; THEISSEN and SYDOW, Ann. Myc. **8** (1915) 254.

MYIOCOPRELLA BAKERI Sacc.

On *Aspidium.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 17—Paete, Laguna Province (*Baker 3829*).

MYIOCOPRON BAKERIANUM Rehm.

On *Passiflora quadrangularis.* BAKER, Philip. Agr. & For. **4** (1914) 163.

MICROPELTELLA CONSIMILIS Rehm.

On *Cryptocarya* sp. Ann. Myc. **15** (1917) 229.

HYPOCREALES

HYPOCREACEÆ

BROOMELLA ZEAE Rehm.

On *Zea mays.* REHM, Leafl. Philip. Bot. **8** (1915) 2923—Los Baños (*Raimundo,* comm. *Baker 1994*); BAKER, Philip. Agr. & For. **5** (1916) 78; Philip. Journ. Sci. **13** (1918) 170; Phytopath. **9** (1919) 140.

MEGALONECTRIA PSEUDOTRICHIA (Schw.) Speg.

On dead bark. Ann. Myc. **15** (1917) 215.
On *Hevea brasiliensis.* Philip. Journ. Sci. **13** (1918) 167.

NECTRIACEÆ

CALONECTRIA COPELANDII P. Henn.

On Orchidaceæ. BAKER, Philip. Agr. & For. **4** (1914) 163.

CALONECTRIA SULCATA Starb.

STARBAECK, Bih. K. Svensk. Vet. Ak. Handl. **25** (1899) 29; ZIMMERMANN, Centralbl. Bakter. **7** (1901) 106 (*C. meliae*).

CALONECTRIA HIBISCOLA P. Henn. (Calonectria meliae A. Zimm.)

SACCARDO and SYDOW, Syll. Fung. 16 (1902) 593; SACCARDO, Syll. Fung. 17 (1905) 810 (*C. meliae*); WEESE, Myc. Centralbl. Apr.-May (1914).

On *Ficus pseudopalma*. REHM, Leafl. Philip. Bot. 8 (1915) 2923—Los Baños (*Raimundo*, comm. *Baker 1397b*).

GIBBERELLA SAUBINETII (Mont.) Sacc.

On *Hibiscus esculentus*. BAKER, Philip. Agr. & For. 4 (1914) 161.

On *Panicum* sp. Leafl. Philip. Bot. 9 (1925) 3135.

LISEA REVOCANS Sacc.

On *Imperata cylindrica*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 23—Los Baños (*Baker 3738*); Ann. Myc. 15 (1917) 214.

NECTRIA BAINII Massee.

On *Theobroma cacao*. Philip. Agr. & For. 4 (1915) 164; Phytopath. 9 (1919) 138.

NECTRIA BAINII Massee var. **HYPOLEUCA** Sacc.

On *Theobroma cacao*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 23—Los Baños (*Baker 3887*); BAKER, Philip. Agr. & For. 5 (1916) 77; Philip. Journ. Sci. 13 (1918) 169.

NECTRIA DISCOPHORA Mont.

MONTAGNE, Syll. gen. sp. Crypt. n. 782 (*Sphaeria*) (1856); SACCARDO, Syll. Fung. 2 (1883) 488; ZIMMERMANN, Centralbl. Bakter. 7 (1901) 106 (*N. striatospora*); SACCARDO and SYDOW, Syll. Fung. 16 (1902) 1140 (*N. striatospora*); WEESE, Gaehrungsphys. 6 (1902) 114–121; DE JONGE, Rec. Trav. Botan. Neerl. 6 (1909) tab. 3, f. 14–17 (*N. striatospora*).

NECTRIA SUBFURFURACEA P. Henn. and Nym.

HENNINGS and NYMANN, Monsunia 1 (1899) 162.

On dead fallen branches. REHM, Leafl. Philip. Bot. 8 (1915) 2922—Mount Maquiling (*Baker 2132*).

NECTRIA TJIBODENSIS Penz. and Sacc. var. **GLIRICIDIAE** Rehm.

On *Gliricidia sepium*. REHM, Leafl. Philip. Bot. 8 (1915) 2922—Los Baños (*Raimundo*, comm. *Baker 1496*).

OPHIONECTRIA ERINACEA Rehm.

On *Bambusa blumeana*. BAKER, Philip. Agr. & For. 4 (1914) 158.

OPHIONECTRIA THEOBROMAE (Pat.) Duss.

On *Theobroma cacao*. BAKER, Philip. Agr. & For. 4 (1914) 164; 4 (1915) 165; 5 (1916) 77; Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 139.

PARANECTRIA LUXURIANS Rehm.

On *Meliola maesae* and *Panicum*. REHM, Leafl. Philip. Bot. 8 (1915) 2924—Los Baños (*Baker 699b*); (*Eladio Sablan*, comm. *Baker 2882b*); (*Baker 2800*).

TRICHONECTRIA BAMBUSICOLA Rehm.

On *Bambusa*. BAKER, Philip. Agr. & For. 3 (1914) 159.

CLAVICIPTÆ

EPICHLOE WARBURGIANA P. Magn.

On *Donax cannaeformis*. Ann. Myc. 15 (1917) 216.

HYPOCRELLA DISCOIDEA (Berk. and Br.) Sacc.

BERKELEY and BROOME, Journ. Linn. Soc. Bot. 14 (1873) 113 (*Hypocrea*); SACCARDO, Michelia 1 (1873) 322; SACCARDO, Syll. Fung. 2 (1883) 580; MASSEE, Kew Bull. 174 (1899) (*H. zingiberis*); SACCARDO and SYDOW, Syll. Fung. 16 (1902) 603; HENNINGS, Hedwigia (1902) 142 (*H. zimmermanniana*); SACCARDO, Syll. Fung. 17 (1905) 817 (*H. zimmermanniana*); KOORDERS, Bot. Untersuch. (1907) 179 (*H. grewiae*); SACCARDO and TROTTER, Syll. Fung. 22 (1913) 503 (*H. grewiae*); PETCH, Ann., Roy. Bot. Gard. Peradeniya 5 (1914) 526 (*Aschersonia*-stage: *A. samoensis* Henn.).

HYPOCRELLA MOLLII Koord.

KOORDERS, Bot. Untersuch. (1907) 179; v. HOEHNEL, Sitz Kais. Akad. Wiss. Wien 118 (1909) Abth. 1. p. 311 (*H. cretacea*); SACCARDO and TROTTER, Syll. Fung. 22 (1913) 504 (*H. mollii*); 506 (*H. cretacea*); PETCH, Ann. Roy. Bot. Gard. Peradeniya 5 (1914) 526 (*Aschersonia*-stage; *A. confluens* Henn.).

HYPOCRELLA RECIBORSKII A. Zimm.

ZIMMERMANN, Centralbl. f. Bakt. 7 (1901) 875; HENNINGS, Engler's Bot. Jahrb. 38 (1905) 13 (*H. warneckiana*); SACCARDO, Syll. Fung. 17 (1905) 818; RACIBORSKI, Bull. Akad. Sci. Cracovie (1906) 909 (*Barya salaccensis*); BAKER, Leafl. Philip. Bot. 6 (1914) 2100; 7 (1914) 2451 (*H. salaccensis*); PETCH, Ann. Roy. Bot. Gard. Peradeniya 5 (1914) 527.

HYPOCRELLA REINECKIANA P. Henn.

HENNINGS, Engler's Bot. Jahrb. 23 (1896) 286; PATOUILLARD, Ann. Bot. Jard. Buitenzorg Suppl. 1 (1897) 125 (*H. pernettyae*); RACIBORSKI, Bull. Acad. Sci. Cracovie (1906) 907 (*H. globosa*); BAKER, Leafl. Philip. Bot. 7 (1914) 2451 (*H. pernettiae*); PETCH, Ann. Roy. Bot. Gard. Peradeniya 5 (1914) 524 (*Aschersonia*-stage; *A. sclerotoides* Henn.).

HYPOCRELLA SALACCENSIS (Rac.) Petch.

On *Premna odorata*. Ann. Myc. 15 (1917) 215.

HYPOCRELLA SCHIZOSTACHYII P. Henn.

On *Schizostachyum*. Philip. Journ. Sci. 13 (1918) 376.

OPHIODOTHIS THANATOSPORA (Lev.) Rac.

LEVEILLE, Ann. Sci. Nat. No. 248 (*Dothidea*) (1845); RACIBORSKI, Bull. Sci. Ak. Crac. (1906) 904.

On *Centotheca latifolia*. REHM, Leafl. Philip. Bot. 8 (1915) 2924—Mount Maquiling (*Baker 2219*).

USTILAGINOIDEA OCHRACEA P. Henn.

On *Panicum* sp. Leafl. Philip. Bot. 9 (1925) 3138.

USTILAGINOIDEA VIRENS (Cke.) Takahashi.

On *Oryza sativa*. BAKER, Philip. Agr. & For. 4 (1914) 163; 5 (1916) 75; Ann. Myc. 15 (1917) 217; Philip. Journ. Sci. 13 (1918) 168, 376; Phytopath. 9 (1919) 130; Philip. Agr. Rev. 19 (1926) 240.

DOTHIDEALES

DOTHIDIACEÆ

AUERSWALDIA EXAMINANS (Mont. and Berk.) Sacc.

MONTAGNE and BERKELEY, Lond. Journ. Bot. 1 (1842) 156 (*Sphaeria*); Pl. Javan. (1842) 520 (*Dothidea*); COOKE, Grevilea 13 (1842) 61; Philip. Agr. & For. 4 (1914) 158; BAKER, Leafl. Philip. Bot. 6 (1914) 2101; Leafl. Philip. Bot. 7 (1914) 2452; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 298.

On *Hevea brasiliensis*. Ann. Myc. 21 (1923) 102.

AUERSWALDIA GIGANTOCHLOAE Rehm.

THEISSEN and SYDOW, Ann. Myc. 13 (1915) 301.

BALANSIA CLAVICEPS Speg.

On *Centotheca latifolia*. Ann. Myc. 15 (1917) 216.

DOTHIDELLA GIGANTOCHLOAE (Rehm) Theiss. and Syd.

On *Gigantochloa scribneriana*. REHM, Leafl. Philip. Bot. 6 (1914) 2223 (*Scirrhia*); BAKER, Leafl. Philip. Bot. 7 (1914) 2462 (*Scirrhia*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 320; 15 (1917) 223.

ELMEROCOCCUM ORBICULA Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2102 (*Darwiniella*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 282.

HETERODOTHIS LEPTOTHECA Syd.

SYDOW, Philip. Journ. Sci. § C 9 (1914) 170; BAKER, Leafl. Philip. Bot. 7 (1914) 2454; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 190 is a lichen and = *Phylloporina phyllogena* Muell.-Arg.

PSEUDOTHIS PTEROCARPI Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2102 (*Dothidea*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 339.

POLYSTOMELLACEÆ

AULACOSTROMA PALAWANENSE Syd.

On *Pandanus tectorius*. BAKER, Leafl. Philip. Bot. 7 (1914) 2453; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 256; 15 (1917) 223.

ELLISIODOTHIS PANDANI Syd.

On *Pandanus luzonensis.* SYDOW, Ann. Myc. (1914) 565—Angat, Bulacan Province; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 247.

ELLISIODOTHIS REHMIANA Theiss. and Syd.

On *Dioscorea esculenta.* BAKER, Leafl. Philip. Bot. **7** (1914) 2460 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. **13** (1915) 248; Philip. Journ. Sci. **13** (1918) 167.

HYSTEROSTOMELLA LETRACERAE (Rud.) v. Hoehnel.

RUD., Linnaea **4** (1829) 118 (*Phacidium*); **5** (1830) 551 (*Phacidium*); SACCARDO, Syll. Fung. **8** (1889) 748 (*Coccomyces*); ELLIS and EVERHART, Journ. Myc. **10** (1904) 167 (*Harknessia*); BAKER, Leafl. Philip. Bot. **7** (1914) 2497; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 224.

HYSTEROSTOMELLA SPURCARIA (Berk. and Br.) v. Hoehn.

BERKELEY and BROOME, Fung. Ceyl. (1870) No. 1131 (*Rhytisma spurcarium*); No. 1132 (*Rhytisma constellatum*); BERKELEY and CURTIS, Journ. Linn. Soc. Bot. **14** (1873) 131 (*Rhytisma*); SACCARDO, Syll. Fung. **8** (1899) 737 (*Marchalia*); v. HOEHNEL, Fragm. Myc. **9** (1899) 56.

On *Artocarpus communis.* REHM, Leafl. Philip. Bot. **8** (1915) 2932—Los Baños (*Baker 2393*); (*Reyes*, comm. *Baker 2557*).

HYSTEROSTOMELLA TETRACERAE (Rud.) v. Hoehn.

On *Tetracera* sp. Ann. Myc. **15** (1917) 220.

INOCYCLUS PSYCHOTRIAE Syd.

BAKER, Leafl. Philip. Bot. **6** (1914) 2136; **7** (1914) 2497 (*Hysterostomella*); THEISSEN and SYDOW, Ann. Myc. **13** (1915) 211.

On *Psychotria luzoniensis.* Philip. Journ. Sci. **12** (1917) 373; Ann. Myc. **15** (1917) 220.

MARCHALIA CONSTELLATA (Berk. and Br.) Sacc.

BERKELEY and BROOME, Journ. Linn. Soc. Bot. **14** (1875) 131 (*Rhytisma constellatum* and *R. spurcarium*); v. HOEHNEL, Fragm. Myc. **9** (1875) No. 448 (*Hysterostomella*); SACCARDO, Syll. Fung. **8** (1899) 737 (*Marchalia spurcaria*).

On *Artocarpus.* THEISSEN and SYDOW, Ann. Myc. **13** (1915) 251—Philippines, Exsicc.: *Sydow, Fung. Exot. 403.*

On *Artocarpus communis.* Philip. Journ. Sci. **13** (1918) 165.

MICRODOTHELLA CULMICOLA Syd.

BAKER, Leafl. Philip. Bot. **7** (1914) 2454; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 259.

PALAWANIA COCOES Syd.

On *Cocos nucifera.* Philip. Agr. & For. **4** (1914) 160; BAKER, Leafl. Philip. Bot. **7** (1914) 2454; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 250; Philip. Journ. Sci. **13** (1918) 166; Phytopath. **9** (1919) 122.

PALAWANIA GRANDIS (Niessl.) Syd.

NIESSL., in Rabh. Fung. Eur. No. 2467 (*Microthyrium*); WINTER, Hedwigia (1886) 107 (*Seynesia*); HENNINGS and E. NYM., (1899) 160 (*Seynesia calamicola*); SACCARDO and SYDOW, Syll. Fung. 16 (1902) 641 (*Seynesia calamicola*); BAKER, Leafl. Philip. Bot. 7 (1914) 2454; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 249.

RHIPIDOCARPON JAVANICUM (Pat.) Theiss. and Syd.

PATOUILLARD, Ann. Jard. Buit. Suppl. (1897) 122 (*Schneepia*); RACIBORSKI, Paras. Alg. und Pilze Javas 2 (1900) 20; (*Lembosia*); SACCARDO and SYDOW, Syll. Fung. 14 (1899) 709 (*Parmularia*); THEISSEN, Ann. Myc. 11 (1912) 453; BAKER, Philip. Agr. & For. 3 (1914) 163 (*Lembosia*); BAKER, Leafl. Philip. Bot. 6 (1914) 2138; 7 (1914) 2441 (*Lembosia*); THEISSEN and SYDOW, Ann. Myc. 13 (1914) 197.

On *Nipa fruticans*. REHM, Leafl. Philip. Bot. 8 (1915) 2933—Los Baños (*Reyes*, comm. *Baker 2548; Mirasol*, comm. *Baker 1220; Catalan*, comm. *Baker 2839*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 197 Exsicc.: *Rehm, Ascom. 1839* (Java); *Sydow, Fung. Exot. 268* (Philippines).

On *Psychotria lusoniensis*. Ann. Myc. 15 (1917) 220.

SCHNEEPIA HYMENOLEPIDIS (P. Henn.) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2137; 7: 2445 (*Parmularia*); SYDOW, Ann. Myc. 13 (1915) 204.

STIGMATODOTHIS PALAWANENSIS Syd.

BAKER, Leafl. Philip. Bot. 7 (1914) 2463; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 264.

ULEOPELTIS BAMBUSINA Syd.

On *Bambusa*. SYDOW, Ann. Myc. 12 (1914) 565—Angat, Bulacan Province; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 218.

PHYLLACHORACEÆ

APIOSPORA APIOSPORA (Dur. and Mtg.) v. Hoehn.

DURAND and MONTAGNE, Crypt. Alger. tab. 1: 492 (*Sphaeria*); MONTAGNE, Syll. Crypt (1856) No. 809 (*Sphaeria*); SACCARDO, Fung. Ven. Ser. 2 (1874) 306 (*A. montagnei*); SACCARDO, Syll. Fung. 1 (1882) 539 (*A. montagnei*); BAKER, Leafl. Philip. Bot. 6 (1914) 2111 (excl. syn. *A. luzonensis*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 419 (*Apiospora montagnei*).

On *Bambusa vulgaris*. REHM, Leafl. Philip. Bot. 8 (1916) 2946—Los Baños (*Reyes*, comm. *Baker 1895, 1435*).

On *Bambusa* sp. Ann. Myc. 16 (1918) 223.

APIOSPORA CAMPTOSPORA Penz. and Sacc.

BAKER, Leafl. Philip. Bot. 7 (1914) 2463; THEISSEN and SYDOW, Ann. Myc. 13 (1915) 421; 15 (1917) 225.

On *Saccharum officinarum*. Philip. Agr. & For. 5 (1916) 343; Philip. Journ. Sci. 13 (1918) 169; Philip. Agr. Rev. 2 (1918) 276; Phytopath. 9 (1919) 136.

APIOSPORA CARBONACEA Rehm.

On *Schizostachyum*. REHM, Leafl. Philip. Bot. 8 (1916) 2945—Mount Maquiling (*Baker 3427a*); Leafl. Philip. Bot. 8 (1915) 2945.

APIOSPORA LUZONENSIS P. Henn.

On *Bambusa*. BAKER, Leafl. Philip. Bot. 6 (1914) 2113 (sub *Apiospora apiospora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 421; 15 (1917) 225.

CATACAUMA APOENSE (Syd.) Theiss. and Syd.

On *Ficus nervosa*. BAKER, Leafl. Philip. Bot. 6 (1914) 2103 (*Phyllachora*); 7: 2455 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 2455; 15 (1917) 224.

CATACAUMA ASPIDEUM (Berk.) Theiss. and Syd. f. **SPINIFERA** (Karst. and Har.) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2106 (*Phyllachora fici-minahassae*); 2110 (*Phyllachora spinifera*); 7: 2457 (*Phyllachora fici-minahassae*); 2460 (*Phyllachora spinifera*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 380.

On *Ficus odorata* (*F. odoratus*). Ann. Myc. 15 (1917) 224; Philip. Journ. Sci. 12 (1917) 374; Ann. Myc. 16 (1918) 215; 21 (1923) 101.

On *Ficus validicaudata*. Philip. Journ. Sci. 13 (1918) 376.

CATACAUMA ASPIDEUM (Berk.) Theiss. and Syd. f. **FICIFULVAE** (Koord.) Theiss. and Syd.

KOORDERS, Verh. K. Akad. Wet. Amsterdam 2 (1907) 183 No. 4; BAKER, Leafl. Philip. Bot. 6 (1914) 2105 (*Phyllachora fici-fulvae*); 7: 2457 (*Phyllachora fici-fulvae*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 381.

On *Ficus* sp. Philip. Journ. Sci. 12 (1917) 374.

On *Ficus odorata* (*F. odoratus*). Ann. Myc. 15 (1917) 224.

CATACAUMA CIRCINATUM (Syd.) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2104 (*Phyllachora*); 7 (1914) 2455 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 2456.

CATACAUMA ELMERI (Syd.) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2105 (*Phyllachora*); 7: 2457 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 378.

On *Ficus* sp. Philip. Journ. Sci. 12 (1917) 375.

On *Ficus minehassa*. Ann. Myc. 15 (1917) 224.

CATACAUMA EURYAE (Rac.) Theiss. and Syd.

RACIBORSKI, Bull. Acad. Cracov. (1909) 377 (*Myocopron*); v. HÖEHNEL, Fragm. Myc. 7 (1912) No. 305 (*Physalospora*); BAKER, Leafl. Philip. Bot. 6 (1914) 2122 (*Physalospora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 392.

CATACAUMA GARCIAE Theiss. and Syd.

On *Ficus garcia*. THEISSEN and SYDOW, Ann. Myc. 13 (1915) 381—Puerto Princesa, Palawan (*Elmer 12847*).

On *Ficus* sp. Leafl. Philip. Bot. 9 (1925) 3136.

CATACAUMA INFECTORIUM (Cke.) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2106 (*Phyllachora*); 7 (1914) 2458 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 384.

CATACAUMA KAERNBACHII (P. Henn.) Theiss. and Syd.

HENNINGS, Engl. Bot. Jahrb. 18 Beibl. 44 (1894) 39 (*Phyllachora*); Syll. Fung. 11: 372 (*Phyllachora*); BAKER, Leafl. Philip. Bot. 6 (1914) 2107 (*Phyllachora*); 7 (1914) 2458 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 376.

CATACAUMA LAGUNENSE (Syd.) Theiss. and Syd.

On *Ficus* sp. BAKER, Leafl. Philip. Bot. 6 (1914) 2107 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 378; 15 (1917) 224; Philip. Journ. Sci. 12 (1917) 374.

On *Ficus hauili*. Ann. Myc. 21 (1923) 101.

CATACAUMA PTEROCARPI (Syd.) Theiss. and Syd.

On *Pterocarpus angalensis*. SYDOW, Ann. Myc. (1912) 40—South Africa; BAKER, Leafl. Philip. Bot. 6 (1914) 2109 (*Phyllachora pterocarpi* non Rehm); 7 (1914) 2459 (*Phyllachora pterocarpi* non Rehm); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 387.

On *Pterocarpus indicus*. Ann. Myc. 15 (1917) 223.

CATACAUMA SANGUINEUM (Rehm) Theiss. and Syd.

On *Ficus heterophylla*. BAKER, Leafl. Philip. Bot. 7 (1914) 2456 (*Phyllachora circinata* var. *sanguinea*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 379; 15 (1917) 224.

CATACAUMA VALSIFORME (Rehm) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2110 (*Phyllachora*); 7 (1914) 2461 (*Phyllachora*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 379.

EXARMIDIUM BLUMEANUM (Rehm) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2110 (*Rhopographus*); 7 (1914) 2462 (*Rhopographus*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 425.

MUNKIODOTHIS MELASTOMATA (v. Hoehn.) Theiss. and Syd.

On *Melastoma fusca*. BAKER, Leafl. Philip. Bot. 6 (1914) 2103 (*Munkiella*); 7 (1914) 2454 (*Munkiella*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 360; 15 (1917) 223.

PHYLLACHORA AFZELIAE Syd.

On *Afzelia bijuga*. Philip. Agr. & For. 4 (1914) 163.

PHYLLACHORA CANARI P. Henn.

On *Canarium villosum*. Philip. Journ. Sci. 12 (1917) 375; Ann. Myc. 16 (1918) 214.

On *Canarium* sp. Leafl. Philip. Bot. 9 (1925) 3136.

PHYLLACHORA COICIS P. Henn.

On *Coix lachryma-jobi*. Philip. Journ. Sci. 12 (1917) 375.

PHYLLACHORA CYNODONTIS (Sacc.) Niessl.

On *Cynodons dactylis.* Ann. Myc. 15 (1917) 227; 26 (1928) 438.

PHYLLACHORA DALBERGIAE Niessl.

On *Dalbergia* sp. Philip. Journ. Sci. 12 (1917) 375.

PHYLLACHORA DIOSCOREA Schwein.

On *Dioscorea* sp. BAKER, Philip. Agr. & For. 4 (1914) 161; Phytopath. 9 (1919) 124.

On *Dioscorea esculenta.* Philip. Journ. Sci. 13 (1918) 167.

PHYLLACHORA LUZONIENSIS P. Henn.

On *Milletia.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 23—Mount Maquiling (*Baker 3840*); Philip. Journ. Sci. 12 (1917) 375; Ann. Myc. 21 (1923) 102.

On *Milletia cavitensis.* Ann. Myc. 15 (1917) 225.

PHYLLACHORA MINUTISSIMA (Welw. and Curr.) Sm.

On *Pennisetum.* WELWITSCH and CURR., Trans. Linn. Soc. Bot. (1868) 285 (*Isothea*)—Angola; SMITH, Journ. Bot. (1898) 179; SACCARDO and SYDOW, Syll. Fung. 16 (1902) 623.

PHYLLACHORA ORBICULA Rehm.

On *Bambusa blumeana.* Philip. Agr. & For. 4 (1914) 158; Ann. Myc. 15 (1917) 227; 16 (1918) 223.

PHYLLACHORA PAHUDIAE Syd.

On *Pahudia rhomboidea.* Ann. Myc. 15 (1917) 225.

PHYLLACHORA PARKIAE P. Henn.

On *Parkia timoriana.* Philip. Agr. & For. 4 (1914) 163.

On *Parkia javanica.* Ann. Myc. 26 (1928) 438.

PHYLLACHORA PHASEOLINA Syd.

BAKER, Philip. Agr. & For. 4 (1914) 163.

On *Phaseolus* sp. Ann. Myc. 15 (1917) 225; Philip. Journ. Sci. 13 (1918) 168.

On *Phaseolus calcaratus.* Phytopath. 9 (1919) 132.

PHYLLACHORA PONGAMIAE (Berk. and Br.) Petch.

On *Pongamia glabra.* Philip. Agr. & For. 4 (1914) 163.

On *Pongamia pinnata.* Philip. Journ. Sci. 12 (1917) 375; Ann. Myc. 21 (1923) 102; 26 (1928) 437.

On *Pongamia mitis.* Ann. Myc. 15 (1917) 225.

PHYLLACHORA REHMIANA Theiss. and Syd.

On *Dioscorea esculenta.* Philip. Journ. Sci. 13 (1918) 167.

PHYLLACHORA ROTTBOELLIAE Syd. and Butl.

On *Rottboellia exaltata.* Leafl. Philip. Bot. 9 (1925) 3136; Ann. Myc. 26 (1928) 438.

PHYLLACHORA ROUREAE Syd.

On *Rourea erecta.* Ann. Myc. 15 (1917) 226.

PHYLLACHORA SACCHARI P. Henn.

On *Saccharum officinarum*. Philip. Agr. & For. **5** (1916) 343; Philip. Agr. Rev. **11** (1918) 275; Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 134; Philip. Agr. Rev. **14** (1921) 430.

PHYLLACHORA SACCHARI-SPONTANEI Syd.

On *Saccharum spontaneum*. Ann. Myc. **15** (1917) 226; Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 134.

PHYLLACHORA SORGHI v. Hoehnel.

On *Andropogon halepensis* (*Sorghum halepensis*) var. *propinquus*. Ann. Myc. **15** (1917) 226; Philip. Journ. Sci. **13** (1918) 377.

On *Andropogon sorghum* (*Sorghum vulgare, Holcus sorghum, Sorghum* sp.). Philip. Journ. Sci. **13** (1918) 165; Ann. Myc. **16** (1918) 214; Phytopath. **9** (1919) 137; Leafl. Philip. Bot. **9** (1925) 3136.

PHYLLACHORA TJANKORREH Rac.

On *Dinochloa* sp. Ann. Myc. **15** (1917) 228.

On *Schizostachyum rotundifolium*. Ann. Myc. **21** (1923) 102.

PHYLLACHORA YAPENSIS (P. Henn.) Syd.

On *Derris elliptica*. Philip. Journ. Sci. **12** (1917) 375.

On *Derris* sp. Ann. Myc. **15** (1917) 225; Leafl. Philip. Bot. **9** (1925) 3136.

RHOPOGRAPHELLA REYESIANA Rehm.

On *Schizostachyum* sp. Ann. Myc. **15** (1917) 209.

PLACOSTROMA PTEROCARPI (Mass.) Theiss. and Syd.

MASSEE, Kew Bull. (1912) 257 (*Dothidella*); BAKER, Leafl. Philip. Bot **6** (1914) 2109 (*Phyllachora pterocarpi* Rehm non Syd.); **7** (1914) 2459 (*Phyllachora pterocarpi* Rehm non Syd.); THEISSEN and SYDOW, Ann. Myc. **13** (1915) 407.

SCHIZOCHORA ELMERI Syd.

BAKER, Leafl. Philip. Bot. **7** (1914) 2462; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 401.

SCIRRHIA BAMBUSINA Penz. and Sacc.

On *Bambusa blumeana*.

SCIRRHIA LUZONENSIS P. Henn.

On *Bambusa blumeana*. Philip. Agr. & For. **4** (1914) 158; BAKER, Leafl. Philip. Bot. **6** (1914) 2111; **7** (1914) 2462; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 418.

SCIRRHODOTHIS BAMBUSINA (Penz. and Sacc.) Theiss. and Syd.

On *Schizostachyum acutiflorum*. BAKER, Leafl. Philip. Bot. **6** (1914) 2111 (*Scirrhia*); THEISSEN and SYDOW, Ann. Myc. **13** (1915) 416; SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 23 (*Baker 3822*).

SCIRRHODOTHIS SERIATA Syd. and Butl.

BAKER, Leafl. Philip. Bot. **6** (1914) 2111 (*Scirrhia*); **7**: 2463 (*Scirrhia*); THEISSEN and SYDOW, Ann. Myc. **13** (1915) 416.

APHERODOTHIS ARENGAE (Rac.) Shear.

On *Caryota rumphiana* var. *philippinensis*. Ann. Myc. **15** (1917) 228; Philip. Journ. Sci. **12** (1917) 375; Leafl. Philip. Bot. **9** (1925) 3136.

TRABUTIA ELMERI Theiss. and Syd.

On *Ficus banahaensis*. THEISSEN and SYDOW, Ann. Mycol. **13** (1915) 353—Mount Apo, Mindanao (*Elmer 10906*).

TRABUTIA FICUUM (Niessl.) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. **6** (1914) 2106 (*Phyllachora ficuum*); THEISSEN and SYDOW, Ann. Myc. **13** (1915) 352.

TRABUTIA VERNICOSA Theiss. and Syd.

On *Ficus heterophylla*. THEISSEN and SYDOW, Ann. Myc. **13** (1915) 353—Mindoro (*Merrill 5625*).

SPHAERIALES

SORDARIACEÆ

SORDARIA ORYZETI Sacc.

On *Oryza sativa*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 19—Los Baños (*Baker 3807*); BAKER, Philip. Agr. & For. **5** (1916) 76; Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 131.

SPHAERIACEÆ

ACANTHOSTIGMA BAMBUSAE v. Hoehn.

V. HOEHNEL, Wiss. Wein. **18**: 334.

On *Bambusa blumeana*. REHM, Leafl. Philip. Bot. **8** (1916) 3951—Los Baños (*Baker 2187*); Mount Maquiling (*Baker 3535*).

ACERBIA MAYDIS Rehm.

On *Zea mays*. REHM, Leafl. Philip. Bot. **8** (1916) 2953—Los Baños (*Raimundo*, comm. *Baker 1993*); BAKER, Philip. Agr. & For. **5** (1916) 78; Philip. Journ. Sci. **13** (1918) 170; Phytopath. **9** (1919) 140.

CHAETOSPHAERIA EXIMIA Sacc.

On *Cocos nucifera*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 20—Los Baños (*Baker 3758*); Philip. Journ. Sci. **13** (1918) 166; Phytopath. **9** (1919) 122.

LASIOSPHAERIA MOLLIS Rehm.

On *Bambusa blumeana*. REHM, Leafl. Philip. Bot. **8** (1916) 2952—Los Baños (*Reyes*, comm. *Baker 1734*).

MELANOMMA MINDORENSE Rehm.

On *Arenga saccharifera*. REHM, Leafl. Philip. Bot. **6** (1914) 2202 (*Metasphaeria maculans*); **8** (1916) 2950—Los Baños (*Baker 1876*).

MELANOPSAMMA LICHENOIDES Rehm.

On fallen limbs. REHM, Leafl. Philip. Bot. **8** (1916) 2944—Los Baños (*Baker 3067a*).

NEOPECKIA RHODOSTICTA (B. and Br.) Sacc.

On *Pandanus*. SACCARDO, Syll. Fung. 2 (1883) 213 (*Herpotrichia*); BERLESE, Atti Congr. Bot. Genova (1892) 5 (*Didymotrichia*); REHM, Leafl. Philip. Bot. 8 (1916) 2946—Los Baños (*Reyes*, comm. *Baker 3440*).

NEOPECKIA RHODOSTICTA (Berk. and Br.) Sacc. var. **MAGNIFICA** Rehm.

On *Pandanus sabutan*. REHM, Leafl. Philip. Bot. 8 (1916) 2947—Los Baños (*Reyes*, comm. *Baker 3047*).

ROSELLINIA BUNODES (Berk. and Br.) Sacc.

BERKELEY and BROOME, Fung. Ceylon (1870) No. 1088 (*Sphaeria*); SACCARDO, Syll. Fung. 1 (1882) 254.

On fallen limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2941—Los Baños (*Reyes*, comm. *Baker*); Ann. Myc. 15 (1917) 211.

ROSELLINIA CALAMI P. Henn.

On *Bambusa blumeana*. Ann. Myc. 15 (1917) 211.

ROSELLINIA COCOES P. Henn.

On *Arenga mindorensis*. Ann. Myc. 15 (1917) 211.

On *Cocos nucifera*. Philip. Journ. Sci. 13 (1918) 167; Phytopath. 9 (1919) 122.

ROSELLINIA (TASSIELLA) CRUSTACEA Rehm.

On *Schizostachyum*. REHM, Leafl. Philip. Bot. 8 (1916) 2941—Los Baños (*Reyes*, comm. *Baker 3372*).

ROSELLINIA DECIPIENS (Rehm) Theiss. and Syd.

BAKER, Leafl. Philip. Bot. 6 (1914) 2101 (*Auerswaldia*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 300.

ROSELLINIA (TASSIELLA) HORRIDA Rehm.

On dead bark. REHM, Leafl. Philip. Bot. 8 (1916) 2941—Mount Maquiling (*Baker 2909*).

ROSELLINIA LAMIPROSTOMA Syd.

On *Streblus asper* and on dead *Daemonorops*. REHM, Leafl. Philip. Bot. 8 (1916) 2942—Los Baños (*Raimundo*, comm. *Baker 2975*); Mount Maquiling (*Baker 2720*).

ROSELLINIA (CONIMELA) MAQUILINGIANA Rehm.

On fallen limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2942—Mount Maquiling (*Reyes*, comm. *Baker 3347*).

ROSELLINIA MEGALOSPERMA Syd.

On *Pipturus arborescens*. Ann. Myc. 15 (1917) 211.

ROSELLINIA MERRILLII Syd.

On decorticated wood. Ann. Myc. 15 (1917) 211.

ROSELLINIA MOLLERIANA Henn.

HENNINGS, Hedwigia 13 (1902).

On decorticated wood. REHM, Leafl. Philip. Bot. 8 (1916) 2942—Mount Maquiling (*Baker 4026*).

ROSELLINIA PROCERA Syd.

On *Alchornea rugosa.* REHM, Leafl. Philip. Bot. 8 (1916) 2942—Los Baños (*Baker 4024*).

ROSELLINIA UMBILICATA Sacc.

On bark. Ann. Myc. 15 (1917) 211.

ZIGNOELLA (TREMATOSTOMA) NOBILIS Rehm.

On *Citrus nobilis.* REHM, Leafl. Philip. Bot. 8 (1916) 2950—Los Baños (*Baker 3229*); BAKER, Philip. Agr. & For. 5 (1916) 74; Phytopath. 9 (1919) 119; REINKING, Philip. Agr. 9 (1920–21) 133; Leafl. Philip. Bot. 8 (1915) 2950; Philip. Journ. Sci. 13 (1918) 166.

CUCURBITARIACEÆ

GIBBERA PHILIPPINENSIS Rehm.

On *Schizostachyum.* REHM, Leafl. Philip. Bot. 8 (1916) 2946—Mount Maquiling (*Baker 2896*).

NITSCHKEA BAMBUSARUM Rehm.

On *Bambusa vulgaris.* REHM, Leafl. Philip. Bot. 8 (1916) 2956—Los Baños (*Reyes,* comm. *Baker 1884, 1886*).

CORYNELIACEÆ

CORYNELIA CLAVATA (L.) Sacc.

On *Podocarpus.* REHM, Leafl. Philip. Bot. 8 (1915) 2925—Mount Banahao (*Copeland,* comm. *Baker 3639*).
On *Podocarpus costatus.* Ann. Myc. 15 (1917) 178.

TRICHOSPHAERIA BAMBUSICOLA Rehm.

On *Bambusa blumeana.* Philip. Agr. & For. 4 (1914) 158.

AMPHISPHAERIACEÆ

AMPHISPHAERIA ARENGAE Rehm.

On *Arenga.* REHM, Leafl. Philip. Bot. 8 (1916) 2947—Los Baños (*Reyes,* comm. *Baker 3436*).

AMPHISPHAERIA SCHIZOSTACHYI Rehm.

On *Schizostachyum.* REHM, Leafl. Philip. Bot. 8 (1916) 2947—Los Baños (*Baker 1966*).

TREMATOSPHAERIA MAQUILINGIANA Rehm.

On *Calamus.* REHM, Leafl. Philip. Bot. 8 (1916) 2952—Mount Maquiling (*Baker 3420*).

TREMATOSPHAERIA MAQUILINGIANA Rehm var. **SCHIZOSTACHYI** Rehm.

On *Schizostachyum.* REHM, Leafl. Philip. Bot. 8 (1916) 2952—Mount Maquiling (*Baker 3426*).

MYCOSPHAERELLACEÆ

ASCOSPORA VANILLAE Rehm.

On *Vanilla* sp. REHM, Leafl. Philip. Bot. 8 (1916) 2935—Los Baños (*Baker 3079*).

GUIGNARDIA ARENGAE Rehm.

On *Caryota* sp. Ann. Myc. **15** (1917) 207.

GUIGNARDIA BAMBUSINA Rehm.

On *Bambusa*. REHM, Leafl. Philip. Bot. **8** (1916) 2936—Los Baños (*Baker 1898, 1915a*).

GUIGNARDIA CREBERRIMA Syd.

On *Capparis horrida*. Philip. Journ. Sci. **12** (1917) 376; Ann. Myc. **15** (1917) 207; Philip. Journ. Sci. **13** (1918) 377.

GUIGNARDIA DINOCHLOAE Rehm.

On *Dinochloa*. REHM, Leafl. Philip. Bot. **8** (1916) 2936—Mount Maquiling (*Baker 2189b*).

GUIGNARDIA MANIHOTI Sacc.

On *Manihot utilissima*. BAKER, Philip. Agr. & For. **3** (1914) 162; Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 128.

GUIGNARDIA MANIHOTI Sacc. var. **DIMINUTA** Sacc.

On *Manihot utilissima*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 18; Philip. Journ. Sci. **13** (1918) 168.

MASSALONGIELLA IMPERATAE Rehm.

On *Imperata cylindrica*. REHM, Leafl. Philip. Bot. **8** (1916) 2956—Los Baños (*Reyes*, comm. *Baker 3120*).

MYCOSPHAERELLA ALOCASIAE Syd.

On *Alocasia indica*. BAKER, Philip. Agr. & For. **3** (1914) 158; Ann. Myc. **15** (1917) 205.

MYCOSPHAERELLA ARISTOLOCHIAE Syd.

Ann. Myc. **15** (1917) 205; Philip. Journ. Sci. **13** (1918) 377; Leafl. Philip. Bot. **9** (1925) 3135.

MYCOSPHAERELLA BRIDELIAE Syd.

On *Bridelia stipularis*. Ann. Myc. **15** (1917) 206.

MYCOSPHAERELLA CARICAE Syd.

On *Carica papaya*. BAKER, Philip. Agr. & For. **3** (1914) 159; Philip. Journ. Sci. **13** (1918) 166; Phytopath. **9** (1919) 118.

MYCOSPHAERELLA MUSAE Speg.

On *Musa cavendishii*. BAKER, Philip. Agr. & For. **3** (1914) 162; Ann. Myc. **15** (1917) 206.

On *Musa sapientum*. Philip. Journ. Sci. **13** (1918) 168; Ann. Myc. **21** (1923) 100; Philip. Agr. Rev. **18** (1925) 582.

On *Musa paradisiaca sapientum*. Phytopath. **9** (1919) 129.

On *Musa textilis*. Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 129.

MYCOSPHAERELLA OCULATA Syd.

On *Premna* sp. Ann. Myc. **15** (1917) 206.

On *Premna odorata*. Philip. Journ. Sci. **13** (1918) 377.

MYCOSPHAERELLA PERICAMPYLI Syd.

On *Pericampylus incanus.* Ann. Myc. **15** (1917) 206; **21** (1923) 99; Leafl. Philip. Bot. **9** (1925) 3135.

MYCOSPHAERELLA REYESII Syd.

On *Sapindus saponaria.* BAKER, Philip. Agr. & For. **4** (1914) 164; Ann. Myc. **15** (1917) 207.

SPHAERULINA SMILACINCOLA Rehm.

Ann. Myc. **20** (1922) 70.

CLYPEOSPHAERIACEÆ

ANTHOSTOMELLA ARECAE Rehm.

On *Areca catechu.* REHM, Leafl. Philip. Bot. **8** (1916) 2938—Los Baños (*Baker 3068*); BAKER, Philip. Agr. & For. **5** (1916) 74; Philip. Journ. Sci. **13** (1918) 165.

ANTHOSTOMELLA ARENGAE (Rac.) Rehm.

RACIBORSKI, Alg. und Pilze Javas **3** (1900) 27 (*Auerswaldia*); REHM, Philip. Journ. Sci. **8** (1900) 395 (*Auerswaldia decipiens*); 399 (*Anthostomella mindorensis*); SYDOW and THEISSEN, Ann. Myc. **13** (1900) 390; REHM, Leafl. Philip. Bot. **8** (1916) 2940; Ann. Myc. **16** (1918) 223, 224.

ANTHOSTOMELLA ATRONITENS Rehm.

On *Donax cannaeformis.* Ann. Myc. **15** (1917) 209.

ANTHOSTOMELLA CALAMI Rehm.

On *Calamus.* REHM, Leafl. Philip. Bot. **8** (1916) 2939—Mount Maquiling (*Baker 3186, 3345; Reyes*, comm. *Baker 3345*).

ANTHOSTOMELLA CALOCARPA Syd.

On *Pandanus sabutan.* Ann. Myc. **15** (1917) 209.

ANTHOSTOMELLA COCOINA Syd.

On *Cocos nucifera.* Philip. Agr. & For. **4** (1914) 160; Philip. Journ. Sci. **13** (1918) 166; Phytopath. **9** (1919) 122.

ANTHOSTOMELLA CORYPHAE Rehm.

On *Corypha elata.* REHM, Leafl. Philip. Bot. **8** (1916) 2940—Los Baños (*Baker 2674*); Ann. Myc. **15** (1917) 209.

ANTHOSTOMELLA CORYPHAE Rehm f. **MINUTISSIMA** Rehm.

On *Corypha elata.* REHM, Leafl. Philip. Bot. **8** (1916) 2940—Los Baños (*Evaristo*, comm. *Baker 2572*).

ANTHOSTOMELLA DONACINA Rehm. f. **ARENGAE** Rehm.

On *Arenga.* REHM, Leafl. Philip. Bot. **8** (1916) 2940—Los Baños (*Baker 1797, 3064*).

ANTHOSTOMELLA EUMORPHA (Sacc. and Paoli) Rehm.

SACCARDO and PAOLI, Myc. Malacc. No. 89 (*Anthostoma eumorphum*). On *Schizostachyum.* REHM, Leafl. Philip. Bot. **8** (1916) 2940—Los Baños (*Baker 2021b*).

ANTHOSTOMELLA GRANDISPORA Penz. and Sacc.

On *Bambusa* and *Schizostachyum*. PENZIG and SACCARDO, Malpighia 11 (1897) 392; REHM, Leafl. Philip. Bot. 8 (1916) 2939—Los Baños (*Reyes*, comm. *Baker 1425*); (*Baker 1954a*).

ANTHOSTOMELLA LUCENS Sacc.

On *Pandanus*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 19—Mount Banahao (*Baker 3860*).

On *Pandanus radicans*. Leafl. Philip. Bot. 9 (1925) 3135.

ANTHOSTOMELLA MICRASPIS (Berk.) Sacc. and Trav.

BERKELEY, Journ. Bot. (1842) 156 (*Sphaeria*); CURREY, Trans. Linn. Soc. Lond. Bot. 20 (1859) 321 (*Sphaeria*); SACCARDO and TRAVERSO, Syll. Fung. 19 (1910) 77; 22 (1913) 101.

On fallen limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2938—Mount Maquiling (*Baker 2908; Reyes*, comm. *Baker 4025*).

ANTHOSTOMELLA MIRABILIS (B. and Br.) v. Hoehn. (Astrocystis mirabilis B. and Br.)

On *Bambusa*. SYDOW, Philip. Journ. Sci. § C 8 (1913) 485 (*A. discophora*); REHM, Leafl. Philip. Bot. 8 (1916) 2939—Los Baños (*Reyes*, comm. *Baker 3055, 3433, 3404, 3652*); Ann. Myc. 15 (1917) 209.

ANTHOSTOMELLA PANDANI (Rehm) Sydow.

On *Pandanus*. BAKER, Leafl. Philip. Bot. 7 (1914) 2453 (*Auerswaldia*); THEISSEN and SYDOW, Ann. Myc. 13 (1915) 300; REHM, Leafl. Philip. Bot. 8 (1916) 2939—Mount Banahao (*Baker 2236*).

ANTHOSTOMELLA UBERIFORMIS Rehm.

On dead trunk. REHM, Leafl. Philip. Bot. 8 (1916) 2937—Mount Maquiling (*Baker 3411*).

ASTROSPHARIELLA FUSISPORA Syd.

On *Bambusa blumeana*. Ann. Myc. 15 (1917) 209.

CEUTHOCARPON DEPOKENSE Penz. and Sacc.

On *Dracontomelum cumingianum*. PENZIG and SACCARDO, Malpighia 9 (1897) 405; REHM, Leafl. Philip. Bot. 8 (1916) 2953—Los Baños (*Raimundo*, comm. *Baker 2191a*).

CEUTHOCARPON PUNCTIFORME Sacc.

On *Sterculia*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 21—Los Baños (*Baker 3893*).

CEUTHOCARPON TALAUMAE Rehm.

On *Talauma villariana*. REHM, Leafl. Philip. Bot. 8 (1916) 2953—Los Baños (*Raimundo*, comm. *Baker 2843*).

CLYPEOSPHAERIA BAKERIANA Rehm.

On *Eugenia bataanensis* and *Grewia stylocarpa*. REHM, Leafl. Philip. Bot. 8 (1916) 2948—Mount Maquiling (*Baker 3481a*); (*Baker 3465*); Ann. Myc. 15 (1917) 209.

DIDYMOSPHAERIA ANISOMERA Sacc.

On *Andropogon sorghum* (*Sorghum vulgare, Holcus sorghum*). SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 20—Los Baños (*Baker 3800*); Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 138.

DIDYMOSPHAERIA CAESPITULOSA Sacc.

On *Premna cumingiana*. Ann. Myc. 13 (1915) 127.

DIDYMOSPHAERIA INCONSPICUA Rehm.

On *Premna odorata*. REHM, Leafl. Philip. Bot. 8 (1916) 2948—Los Baños (*Baker 2110b*).

DIDYMOSPHAERIA STRITULA Penz. and Sacc.

On *Bambusa vulgaris, Calamus*, and *Schizostachyum* sp. REHM, Leafl. Philip. Bot. 8 (1916) 2948—Los Baños (*Reyes*, comm. *Baker 1903*); Mount Maquiling (*Reyes*, comm. *Baker 3344, 3345*); Ann. Myc. 15 (1917) 208.

LINOSPORA ELASTICAE Koord.

KOORDERS, Bot. Untersuch (1917) 193.

On *Ficus*. REHM, Leafl. Philip. Bot. 8 (1916) 2954—Mount Maquiling (*Copeland*, comm. *Baker 3179a*).

LINOSPORA PANDANI Rehm.

On *Pandanus sabotan* and *P. utilissima*. REHM, Leafl. Philip. Bot. 8 (1916) 2954—Los Baños (*Reyes*, comm. *Baker 3045*); Mount Banahao (*Baker 2248*).

LINOSPORA SERIATA (Syd.) Rehm.

On *Bambusa blumeana*. SYDOW, Philip. Journ. Sci. 8 (1916) 272 (*Ophiobolus*); REHM, Leafl. Philip. Bot. 8 (1916) 2954—Mount Maquiling (*Baker 3417*).

PLEOSPORACEÆ

DIDYMELLA CARICAE Tassi.

On *Carica papaya*. Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 118.

DIDYMELLA EUTYPOIDES Rehm.

On *Bambusa*. REHM, Leafl. Philip. Bot. 8 (1916) 2943—Los Baños (*Reyes*, comm. *Baker 1915c*).

DIDYMELLA LUSSONIENSIS Sacc.

On *Dolichos uniflorus*. BAKER, Philip. Agr. & For. 3 (1914) 161; Phytopath. 9 (1919) 132.

On *Dolichos lablab*. Philip. Journ. Sci. 13 (1918) 167.

DIDYMELLA ORCHNODES Rehm.

On *Goniothalamus*. REHM, Leafl. Philip. Bot. 8 (1916) 2943—Mount Maquiling (*Baker 3085a*).

DIDYMELLA SERIATA Rehm.

On *Schizostachyum*. REHM, Leafl. Philip. Bot. 8 (1916) 2943—Los Baños (*Baker 1954b*).

DIDYMOSPHAERIA CAESPITULOSA Sacc.

On *Premna cumingiana.* SACCARDO, Ann. Myc. **13** (1915) 127—Los Baños (*Baker 2746*).

DIDYMOSPHAERIA STRIATULA Penz. and Sacc.

REHM, Leafl. Philip. Bot. **6** (1914) 2223—(*Phaodothis gigantochloae*); BAKER, Leafl. Philip. Bot. **8** (1914) 2455; THEISSEN and SYDOW, Ann. Myc. **13** (1915) 185.

LEPTOSPHAERIA ORTHOGRAMMA (B. and C.) Sacc.

BERKELEY and CURTIS, Cent. N. Am. Fung. (1853) No. 922 (*Sphaeria*); SACCARDO, Syll. Fung. **2** (1883) 60.

On *Zea mays.* REHM, Leafl. Philip. Bot. **8** (1916) 2951—Los Baños (*Raimundo,* comm. *Baker 1996*); BAKER, Philip. Agr. & For. **5** (1916) 78; Philip. Journ. Sci. **13** (1918) 170.

METASPHAERIA CORRUSCANS Rehm.

On *Capparis horrida.* REHM, Leafl. Philip. Bot. **8** (1916) 2950—Los Baños (*Baker 1429b*).

METASPHAERIA INCOMPLETA Rehm.

On *Eugenia.* REHM, Leafl. Philip. Bot. **8** (1916) 2949—Mount Maquiling (*Baker 2936b*).

OPHIOCHAETE BAKERIANA Sacc.

On *Calamus.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 21—Mount Maquiling (*Baker 3775*).

PHYSALOSPORA AFFINIS Sacc.

On *Theobroma cacao.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 18—Los Baños (*Baker 3779*); BAKER, Philip. Agr. & For. **5** (1916) 77; Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 138.

PHYSALOSPORA BAMBUSAE (Rabh.) Sacc.

On *Bambusa.* BAKER, Philip. Agr. & For. **3** (1914) 159.

PHYSALOSPORA BAMBUSICOLA Rehm.

On *Bambusa.* BAKER, Philip. Agr. & For. **3** (1914) 159.

PHYSALOSPORA DINOCHLOAE Rehm.

On *Dinochloa.* REHM, Leafl. Philip. Bot. **8** (1916) 2937—Mount Maquiling (*Baker 2189a*).

PHYSALOSPORA GUIGNARDIOIDES Sacc.

On *Canavalia gladiata.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 19—Los Baños (*Baker 3809*); BAKER Philip. Agr. & For. **5** (1916) 74; Philip. Journ. Sci. **13** (1918) 166.

On *Phaseolus* spp. Phytopath. **9** (1919) 132.

PHYSALOSPORA HOYAE v. Hoehn.

V. HOEHNEL, Kais. Ak. Wiess. Wien **114** (1907) 122.

On *Hoya luzonica.* SYDOW, Leafl. Philip. Bot. **6** (1914) 2122 (*P. hoyae*); REHM, Leafl. Philip. Bot. **8** (1916) 2937—Los Baños (*Baker 3093*); Ann. Myc. **15** (1917) 207.

PHYSALOSPORA PERIBAMBUSINA Rehm.

On *Bambusa vulgaris*. REHM, Leafl. Philip. Bot. 8 (1916) 2937—Los Baños (BAKER *6*; *Reyes*, comm. *Baker 1896, 1901*).

TEPHROSTICTA FICINA Syd.

On *Payena leeri*. Ann. Myc. 15 (1917) 179.
On *Coix lacryma-jobi*. Ann. Myc. 15 (1917) 208.

OPHIOBOLUS HETEROSTROPHUS Drechsler.

Journ. Agr. Res. 31 (1925) 701–726; Philip. Agr. 19 (1931) 581–589.

OPHIOBOLUS NIPAE Henn.

On *Nipa fructicans*. BAKER, Philip. Agr. & For. 3 (1914) 163.

OPHIOBOLUS ORYZAE I. Miyake.

Journ. Coll. Agr., Imp. Univ. Tokyo 2 (1910) 237–276.

OPHIOBOLUS ORYZINUS Sacc.

On *Oryza sativa*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 21—Los Baños (*Baker 3774, 3803* err. *3305*); BAKER, Philip. Agr. & For. 5 (1916) 76; REINKING, Philip. Journ. Sci. 13 (1918) 168; REINKING, Phytopath. 9 (1919) 131.

MASSARIACEÆ

MASSARIA BATAANENSIS Rehm.

On *Eugenia bataanensis*. REHM, Leafl. Philip. Bot. 8 (1916) 2951—Mount Maquiling (*Baker 3481b*).

MASSARINA RAIMUNDOI Rehm.

On *Citrus nobilis*. BAKER, Philip. Agr. & For. 3 (1914) 160; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 119.

MASSARINULA BAMBUSICOLA Rehm.

On *Bambusa vulgaris*. REHM, Leafl. Philip. Bot. 8 (1916) 2944—Los Baños (*Reyes*, comm. *Baker 1915b*).

MASSARINULA DONACINA Rehm.

On *Donax cannaeformis*. REHM, Leafl. Philip. Bot. 8 (1916) 2944—Los Baños (*Raimundo*, comm. *Baker 2013*).

MASSARINULA OBLIQUA Sacc.

On *Mischocarpus fuscescens*. SACCARDO, Ann. Myc. 13 (1915) 127—Los Baños (*Baker 2253*).

MASSARINA RAIMUNDOI Rehm.

On *Citrus nobilis*. REINKING, Philip. Agr. 9 (1920–21) 133.

GNOMONIACEÆ

GLOMERELLA CINGULATA (Stonem.) S. and v. S.

On *Persea americana* and *Mangifera indica*. Philip. Agr. 15 (1926) 128; Philip. Agr. Rev. 20 (1926) 271; 21 (1926) 81.
On *Lagenaria leucantha*. Philip. Agr. 14 (1926) 213.

PHOMATOSPORA MIGRANS Rehm.

On *Arenga saccharifera.* REHM, Leafl. Philip. Bot. 8 (1916) 2936 Los Baños (*Reyes*, comm. *Baker 1455*); BAKER, Philip. Agr. & For. 5 (1916) 74; Ann. Myc. 16 (1918) 216.

VALSACEÆ

DIAPORTHE CITRINCOLA Rehm.

On *Citrus nobilis.* BAKER, Philip. Agr. & For. 3 (1914) 160; Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 119; REINKING, Philip. Agr. 9 (1920–21) 133.

DIAPORTHE RECONDITA Sacc.

On *Gliricidia maculata.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 22—Los Baños (*Baker 3793*).

ENDOXYLA MANGIFERAE Henn.

On *Mangifera indica.* BAKER, Philip. Agr. & For. 3 (1914) 162; Philip. Journ. Sci. 13 (1918) 167; Phytopath. 9 (1919) 127.

EUTYPA BAMBUSINA Penz. and Sacc.

On *Bambusa blumeana.* BAKER, Philip. Agr. & For. 3 (1914) 159.
On dead culms of bamboo. Philip. Journ. Sci. 12 (1917) 377.
On *Bambusa* and *Schizostachyum.* Ann. Myc. 15 (1917) 213.
On *Schizostachyum lumampao.* Ann. Myc. 21 (1923) 101.
On *Bambusa* sp. Ann. Myc. 26 (1928) 431.

EUTYPA HETERACANTHA Sacc.

Syll. Fung. 1: 177; 9: 466.
On *Citrus decumana.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 22—Los Baños (*Baker 3897*); Phytopath. 9 (1919) 119.
On *Citrus maxima.* REINKING, Philip. Agr. 9 (1920–21) 134.

EUTYPA LUDIBUNDA Sacc.

On branches. Ann. Myc. 15 (1917) 213.

PERONEUTYPELLA ARECAE Sydow.

On *Areca catechu.* Philip. Agr. & For. 4 (1914) 158; REINKING, Philip. Journ. Sci. 13 (1918) 165.
On *Cocos nucifera.* Ann. Myc. 15 (1917) 213; Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 122.

PERONEUTYPELLA GRAPHIDIOIDES Syd.

On *Terminalia catappa.* Phytopath. 9 (1919) 138.

EUTYPELLA CITRICOLA Speg.

On *Citrus nobilis.* BAKER, Philip. Agr. & For. 3 (1914) 160; SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 22—Los Baños (*Baker 3898*).
On *Citrus maxima.* Philip. Journ. Sci. 13 (1918) 165; 166; Phytopath. 9 (1919) 119; REINKING, Philip. Agr. 9 (1920–21) 133, 134.
On *Citrus aurantifolia.* Ann. Myc. 21 (1923) 101.

EUTYPELLA COCOS Ferd. and Winge.

On *Cocos nucifera.* Philip. Agr. & For. 4 (1914) 160; Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 122.

EUTYPELLA LEUCAENAE Rehm.

On *Leucaena glauca.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 22—Los Baños (*Baker 3741*).

EUTYPELLA LINEOLATA Rehm.

On *Mallotus philippinensis.* REHM, Leafl. Philip. Bot. 8 (1916) 2955—Los Baños (*Baker 3060b*).

EUTYPELLA MALLOTI Rehm.

On *Mallotus philippinensis.* REHM, Leafl. Philip. Bot. 8 (1916) 2955—Los Baños (*Baker 3060a*).

EUTYPELLA REHMIANA (Henn. and Nym.) v. Höhnel.

On *Areca catechu.* Philip. Journ. Sci. 13 (1918) 165.

THYRIDARIA CALAMINCOLA Rehm.

On *Calamus.* REHM, Leafl. Philip. Bot. 8 (1916) 2957—Mount Maquiling (*Baker 3230b*).

THYRIDARIA EMINENS Rehm.

On *Streblus asper.* REHM, Leafl. Philip. Bot. 8 (1916) 2957—Los Baños (*Raimundo,* comm. *Baker 2977*).

THYRIDARIA TARDA Bancroft.

On *Theobroma cacao.* Philip. Agr. & For. 4 (1915) 164; Phytopath. 9 (1919) 138.

MELANCONIDACEÆ

VALSARIA CITRI Rehm.

On *Citrus nobilis.* BAKER, Philip. Agr. & For. 3 (1914) 160; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 119; Philip. Agr. 9 (1920–21) 133.

VALSARIA INSITIVA (de Not) Ces. and de Not.

On *Morus alba.* BAKER, Philip. Agr. & For. 3 (1914) 162; REINKING, Philip. Journ. Sci. 13 (1918) 168; Phytopath. 9 (1919) 128.

DIATRYPACEÆ

DIATRYPELLA BARLERIAE Syd.

On *Barleria cristata.* BAKER, Philip. Agr. & For. 5 (1916) 74—Los Baños.

DIATRYPELLA PSIDII Syd.

On *Psidium guajava.* REINKING, Phytopath. 9 (1919) 133.

MELOGRAMMATACEÆ

BOTRYOSPHAERIA MINUSCULA Sacc.

On *Theobroma cacao.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 18—Los Baños (*Baker 3777, 3780*); BAKER, Philip. Agr. & For. 5 (1916) 77; REINKING, Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 139.

XYLARIACEÆ

HYPOXYLON ANNULATUM (Schw.) Mont.

On dead bark. REHM, Leafl. Philip. Bot. 8 (1916) 2957—Los Baños (*Baker 2906*); Ann. Myc. 15 (1917) 211.

HYPOXYLON ATROPURPUREUM Fr.

On *Citrus nobilis*. Philip. Journ. Sci. 13 (1918) 166.

On coccids. REINKING, Phytopath. 9 (1919) 119; Philip. Agr. 9 (1920–21) 133.

HYPOXYLON CULMORUM Cke.

On *Schizostachyum* sp. Ann. Myc. 15 (1917) 212.

HYPOXYLON EFFUSUM Nitsch.

On bark of dead trees in the forest. Philip. Journ. Sci. 12 (1917) 378.

HYPOXYLON FREYCINETIAE Rehm.

On *Freycinetia*. REHM, Leafl. Philip. Bot. 8 (1916) 2959—Mount Maquiling (*Baker 3416*); Ann. Myc. 15 (1917) 211; 21 (1923) 101.

HYPOXYLON GRANULOSUM Bull.

BULLIARD, Champ. (1791) 176.

On dead branches. REHM, Leafl. Philip. Bot. 8 (1916) 2958—Los Baños (*Reyes*, comm. *Baker 2838*).

HYPOXYLON HAEMATOSTROMA Mont.

On *Schizostachyum* and *Bambusa*. REHM, Leafl. Philip. Bot. 8 (1916) 2958—Mount Maquiling (*Baker 3904*); (*Reyes*, comm. *Baker 1894a*).

HYPOXYLON MARGINATUM (Schw.) Berk.

On dead limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2958—Mount Maquiling (*Baker 3483*).

On wood. Ann. Myc. 15 (1917) 211.

On bark of dead trees in the forest. Philip. Journ. Sci. 12 (1917) 378.

HYPOXYLON MARGINATUM (Schw.) Berk. var. MAMMIFORME Rehm.

On fallen limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2958—Mount Maquiling (*Baker 3038*).

HYPOXYLON RUBIGINEO-AREOLATUM Rehm var. MICROSPORUM Theiss.

THEISSEN, Ann. Myc. 6: 345.

On *Polyscias nodosa*. REHM, Leafl. Philip. Bot. 8 (1916) 2958—Mount Maquiling (*Baker 2894*).

On dead stems. Ann. Myc. 15 (1917) 212.

HYPOXYLON SUBEFFUSUM Speg.

SPEGAZZINI, Fung. Gnar. Pug. 1: No. 204; SACCARDO, Syll. Fung. 9 (1891) 556.

On rotten limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2958—Los Baños (*Reyes*, comm. *Baker 2837*); Ann. Myc. 15 (1917) 217.

KRETZMARIA GHOMPHOIDEA Penz. and Sacc.

On rotten wood in forests. Philip. Journ. Sci. 12 (1917) 379.

NUMMULARIA CITRINCOLA Rehm.

On *Citrus*. REHM, Leafl. Philip. Bot. 8 (1916) 2961—Los Baños (*Baker 3062*); REINKING, Philip. Agr. 9 (1920–21) 134.

NUMMULARIA FRAGILLIMA Rehm.

On *Calamus*. REHM, Leafl. Philip. Bot. 8 (1916) 2959—Mount Maquiling (*Baker 3187*).

NUMMULARIA GLYCYRRHIZA (B. and C.) Sacc.

On dead trunk. Ann. Myc. 15 (1917) 212.

NUMMULARIA LIANAE Rehm.

On a liana, perhaps *Bauhinia*. REHM, Leafl. Philip. Bot. 8 (1916) 2959—Mount Maquiling (*Baker 2881*).

NUMMULARIA MEMORABILIS Rehm.

On dead wood. REHM, Leafl. Philip. Bot. 8 (1916) 2960—Mount Maquiling (*Baker 3432*).

NUMMULARIA PAPYRACEA Rehm.

On dead trunk. Ann. Myc. 15 (1917) 212.

NUMMULARIA REYESIANA Rehm.

On *Bambusa* sp. and *B. blumeana*. REHM, Leafl. Philip. Bot. 8 (1916) 2960—Los Baños (*Reyes*, comm. *Baker 1906*); (*Baker 1114, 1624, 2574*); REHM, Leafl. Philip. Bot. 6: 2203—*Hypoxylon culmorum*, non Cke.).

On dead stems of bamboo. Philip. Journ Sci. 12 (1917) 378.

NUMMULARIA SCUTATA B. and C.

On fallen limbs and on *Cyrilla*. REHM, Leafl. Philip. Bot. 8 (1916) 2961—Mount Maquiling (*Baker 3419, 3431*); (*Baker 3414*).

NUMMULARIA URCEOLATA Rehm.

On bark. Ann. Myc. 15 (1917) 212.

XYLARIACEÆ

DALDINIA CONCENTRICA (Bolt.) Ces. and de Not.

On dead logs. Philip. Journ. Sci. 13 (1918) 378.

On *Citrus maxima*. REINKING, Philip. Agr. 9 (1920–21) 134.

On trunks of trees. Ann. Myc. 15 (1917) 212.

DALDINIA CONCENTRICA var. MICROSPORA (Starb.) Theiss.

On trunks of trees. Ann. Myc. 15 (1917) 212.

DALDINIA ESCHOLZII Ehr.

On trunks of trees. Ann. Myc. 15 (1917) 212.

XYLARIA ALLANTOIDEA Berk.

Ann. Myc. 15 (1917) 213.

XYLARIA CASTOREA Berk.

REINKING, Philip. Agr. 9 (1920–21) 133.

XYLARIA CORNIFORMIS Fr.

On rotten logs. Philip. Journ. Sci. 12 (1917) 379.

XYLARIA EUGLOSSIA Fr.

On rotten logs. Ann. Myc. 15 (1917) 213.

XYLARIA GRAMMICA Mont.

On logs. Ann. Myc. 15 (1917) 213.

XYLARIA HYPOXYLON (L.) Grev. f. TROPICA Syd.

On rotting logs. Ann. Myc. 15 (1917) 212.

XYLARIA LUZONENSIS Henn.

On dead pods of *Bauhinia* lying on the ground in dense forests. Philip. Journ. Sci. 12 (1917) 379.

XYLARIA NIGRIPES (Klot.) Sacc.

On deserted termite nests. Philip. Journ. Sci. 13 (1918) 227.

XYLARIA OBVATA Berk.

On logs. Ann. Myc. 15 (1917) 213.

XYLARIA PLEBEJA Ces.

On bark. Ann. Myc. 15 (1917) 213.

XYLARIA TABACINA (Kickx.) Berk.

On dead limbs. REHM, Leafl. Philip. Bot. 8 (1916) 2961—Mount Maquiling (*Baker 3395*).

XYLARIA TUBEROSA (Pers.) Cke.

On rotting wood and logs. Ann. Myc. 15 (1917) 213.

HYSTERIALES

HYPODERMATACEÆ

LOPHODERMIUM ALEURITIS Rehm.

On dead leaves. REHM, Leafl. Philip. Bot. 8 (1915) 2925—Los Baños (*Baker 3444*).

LOPHODERMIUM ARUNDINACEUM (Schrad.) Chev.

SCHRADER, Journ. f. d. Bot. 2 (1799) 62 (*Hysterium*); FRIES, Syst. Myc. 2 (1821) 590 (*Hysterium*); CHEVALIER, Flor. par. 1 (1826) 435; SACCARDO, Syll. Fung. 2 (1883) 795.

On dead leaves of *Livistona*. REHM, Leafl. Philip. Bot. 8 (1915) 2925—Mount Maquiling (*Baker 3422*).

LOPHODERMIUM ARUNDINACEUM (Schrad.) Chev. f. VULGARE Fckl.

On dead *Miscanthus japonicus*. REHM, Leafl. Philip. Bot. 8 (1915) 2926—Mount Maquiling (*Baker 3527, 3540*).

LOPHODERMIUM PASSIFLORAE Rehm.

BAKER, Philip. Agr. & For. 3 (1914) 163.

LOPHODERMIUM PLANCHONIAE Rehm.

On dead leaves of *Planchonia spectabilis*. REHM, Leafl. Philip. Bot. 8 (1915) 2925—Los Baños (*Baker 3080*).

LOPHODERMIUM ROTUNDATUM Syd.

On *Canarium* sp. Ann. Myc. 15 (1917) 251.

HYSTERIACEÆ

ALDONA STELLA NIGRA Rac.

On *Pterocarpus* sp. Leafl. Philip. Bot. 9 (1925) 3137.

HYSTERIUM ANCEPS Sacc.

On *Streblus asper*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 24—Los Baños (*Baker 3831*).

SCHIZOTHYRIUM ACERIS (P. Henn. and Lind.) Pat.

On *Acer* sp. Ann. Myc. 15 (1917) 251.
On *Acer niveum*. Ann. Myc. 21 (1923) 104.

PEZIZALES

CENANGIACEÆ

CENANGIUM BLUMEANUM Rehm.

On dead *Bambusa blumeana*. REHM, Leafl. Philip. Bot. 8 (1915) 2927—Los Baños (*Raimundo*, comm. *Baker 2927b*).

PATELLARIACEÆ

LAGERHEIMA DERMATOIDEA Rehm.

On dead *Derris philippinensis*. REHM, Leafl. Philip. Bot. 8 (1915) 2928—Los Baños (*Baker 2006a*).

PACHYPATELLA ALSOPHILAE (Rac.) Theiss. and Syd.

On *Alsophila*. RACIBORSKI, Paras. Alg. und Pilze Javas 2 (1900) 22 (*Hysterostomella*)—Java; SYDOW, Philip. Journ. Sci. § C 8 (1913) 495 (*Discodothis lobata* Syd.); BAKER, Leafl. Philip. Bot. 6 (1914) 2102 (*Discodothis lobata*).
On *Cyathea caudata*. THEISSEN and SYDOW, Ann. Myc. 13 (1915) 228; 15 (1917) 252.

BULGARIACEÆ

BULGARIASTRUM CAESPITOSUM Syd.

On *Capparis sepiaria*. Philip. Journ. Sci. 13 (1918) 361.

MOLLISIACEÆ

CALOPEZIZA MIRABILIS Syd.

On *Premna odorata*. Ann. Myc. 15 (1917) 218.

MOLLISIA RAVIDA Sydow.

On *Lagerstroemia indica* and *L. speciosa*. Philip. Agr. & For. 4 (1914) 161.

NIPTERA GREWIAE Rehm.

On leaves of *Grewia*. REHM, Leafl. Philip. Bot. 8 (1915) 2928—Los Baños (*Baker 2885*).

TRICHOBELONIUM MELIOLOIDES Rehm.

On leaves of *Gigantochloa scribneriana.* REHM, Leafl. Philip. Bot. 8 (1915) 2929—Hills back of Paete, Luzon (*Baker 3115*).

HELOTIACEÆ

SCLEROTINIA NERVISEQUIA Schroet. v. **BAMBUSACEA** Rehm.

On dead *Bambusa vulgaris* and on dead leaves of *Dimerocalyx longipes.* REHM, Leafl. Philip. Bot. 8 (1915) 2930—Los Baños (*Reyes*, comm. *Baker 1911*); Mount Maquiling (*Reyes*, comm. *Baker 4119*, err. *3221*).

PEZIZACEÆ

HUMARIA CABALLINA Rehm.

On horse dung. REHM, Leafl. Philip. Bot. 8 (1915) 2930—Mount Maquiling (*Copeland*, comm. *Baker 3637*).

LACHNEA LIVIDA (Schum.) Gill.

SACCARDO, Syll. Fung. 8: 187.

On decaying plant remains on ground. SACCARDO, Nuovo Giorn. Bot. 23 (1916) 24—Los Baños (*Baker 2896*, err. *3897*).

LACHNEA LURIDA P. Henn. and E. Nym.

On *Polyporus.* Ann. Myc. 15 (1917) 252.

PEZIZELLA OMBROPHILACEA Rehm.

On leaves of *Psidium guajava.* REHM, Leafl. Philip. Bot. 8 (1915) 2929—Los Baños (*Raimundo*, comm. *Baker 1984*); BAKER, Philip. Agr. & For. 5 (1916) 76; Phytopath. 9 (1919) 133.

PILOCRATERA TRICHOLOMA (Mont.) P. Henn.

On logs. Ann. Myc. 15 (1917) 252.

PLICARIA BANANINCOLA Rehm.

On *Musa sapientum.* Philip. Journ. Sci. 13 (1918) 168.

On *Musa paradisiaca sapientum.* Phytopath. 9 (1919) 129.

PLICARIA TROPICA Rehm.

On burnt *Bambusa.* REHM, Leafl. Philip. Bot. 8 (1915) 2931—Los Baños (*Raimundo*, comm. *Baker 1445*).

TRIBLIDIACEÆ

TRYBLIDIELLA MINDANAENSIS P. Henn.

On branches. Ann. Myc. 15 (1917) 251.

On *Premna.* Philip. Journ. Sci. 12 (1917) 362.

On *Hevea brasiliensis.* Philip. Journ. Sci. 13 (1918) 167, 362.

On *Citrus nobilis.* Philip. Journ. Sci. 13 (1918) 166; REINKING, Philip. Agr. 9 (1920–21) 133.

On *Aberia gardneri.* Ann. Myc. 21 (1923) 104.

TRYBLIDIELLA RUFULA (Spreng.) Sacc.

On *Citrus nobilis.* Philip. Journ. Sci. 13 (1918) 166; REINKING, Philip. Agr. 9 (1920–21) 133.

PHACIDIALES

STICTIDACEÆ

BRIARDIA MAQUILINGIANA Rehm.

On *Tetrastigma*. REHM, Leafl. Philip. Bot. 8 (1915) 2927—Mount Maquiling (*Reyes*, comm. *Baker 3320*).

PROPOLIDIOPSIS ARENGA Rehm.

On *Arenga*. REHM, Leafl. Philip. Bot. 8 (1915) 2927—Los Baños (*Baker 2899*).

PHACIDIACEÆ

COCCOMYCES DUBIUS Rehm.

On *Ficus minahassae*. REHM, Leafl. Philip. Bot. 8 (1915) 2926—Los Baños (*Reyes*, comm. *Baker 3480*).

COCCOMYCES QUADRATUS (Schw. and Kzc.) Karst. var. **PHILIPPINUS** Rehm.

On dead leaves of *Neolitsea*. REHM, Leafl. Philip. Bot. 8 (1915) 2926—Mount Maquiling (*Baker 3446*).

RHAGADOLOBIUM BAKERIANUM Sacc.

On *Cyathus*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 24—Mount Maquiling (*Baker 3841*); Ann. Myc. 20 (1922) 73.

RHYTISMA LAGERSTROEMIA Rabh.

RABENHORST, Hedw. 31 (1878); BERKELEY and BROOME, Grev. 6 (1878) 110 (*R. pongamiae*).

On *Lagerstroemia indica* and *L. speciosa*. Philip. Agr. & For. 4 (1914) 161; REHM, Leafl. Philip. Bot. 8 (1915) 2926—Morong Valley, Rizal Province (*Raimundo*, comm. *Baker 2580*); Philip. Journ. Sci. 12 (1917) 362; Ann. Myc. 15 (1917) 251.

MYRIANGIALES

ELSINOEÆ

ELSINOE CANAVALIAE Rac.

On *Canavalia ensiformis*. BAKER, Philip. Agr. & For. 3 (1914) 159; Ann. Myc. 15 (1917) 255.

On *Canavalia gladiata*. Philip. Journ. Sci. 13 (1918) 165.

On *Phaseolus* spp. Phytopath. 9 (1919) 132.

MYRIANGIUM DURIAEI Mont.

On coccids. REINKING, Philip. Agr. 9 (1920–21) 133, 146.

PHYCOMYCETES

OOMYCETES

CHYTRIDIALES

SYNCHYTRIACEÆ

WORONINELLA AECIDIOIDES (Peck.) Syd.

PECK, 24th Rep. N. Y. State Mus. 88 (1872) (*Uredo*); THUEMEN, Myc. Univ. No. 538 (1876) (*Uredo peckii*); FARLOW, Bull. Bussey Inst. 2

(1878) 229 (*Synchytrium fulgens* v. *decipiens*); FARLOW, Bot. Gaz. **10** (1885) 240 (*Synchytrium decipiens*); PECK, in C. L. Shear, N. Y. Fungi. Exsicc. No. 126 (1895) (*Synchytrium aecidioides*); WILSON and SEAVER, Ascom. & Lower Fungi. Exsicc. No. 72 (*Synchytrium aecidioides*) (1909); WILSON and SEAVER, Mycologia **1** (1909) 272 (*Synchytrium aecidioides*); BAKER, Leafl. Philip. Bot. **6** (1914) 2149 (*Synchytrium aecidioides*); SYDOW, Ann. Myc. **12** (1914) 485.

WORONINELLA DOLICHI (Cke.) Syd.

COOKE, Grevilea **10** (1882) 127 (*Aecidium*); HENNINGS, Engl. Bot. Jahrb. **38** (1905) 103 (*Uromyces vignicola*); SYDOW, Ann. Myc. **12** (1914) 486—On *Dolichos gibbosus, Glycine javanica, Dunbaria ferrignes,* and *Vigna sinensis* in Ant. Africa, South Africa, India, and Philippines.

On *Dolichos lablab*. Philip. Journ. Sci. **13** (1918) 167.

WORONINELLA PSOPHOCARPI Rac.

RACIBORSKI, Zeitschr. f. Pflanzenk 195 (1898); SYDOW, Ann. Myc. **1** (1903) 15 (*Uromyces*); **13** (1914) 486—On *Psophocarpus* in Java, Philippines, and West Africa.

On *Psophocarpus tetragonolobus*. BAKER, Philip. Agr. & For. **5** (1916) 76; Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 133; Ann. Myc. **26** (1928) 414.

WORONINELLA PUERARIAE (Henn.) Syd.

HENNINGS, Engl. Bot. Jahrb. **15** (1892) 6 (*Aecidium*); DIETEL, Engl. Bot. Jahrb. **28** (1900) 282 (*Uromyces*); MIYABE, Bot. Mag. Tokyo **19** (1905) 199 (*Synchytrium*); SYDOW, Ann. Myc. **12** (1914) 486—On *Pueraria* in Java, New Guinea, Philippines, and Japan.

MYCOCHYTRIDIACEÆ

AMPHOROMORPHA ENTOMOPHILA Thaxter.

THAXTER, Bot. Gaz. **58** (1914) 251—Manila, on *Diochus conicicallis* Mots. and on *Labia* sp. (*Banks*).

PYTHIACEÆ

PYTHIUM DEBARYANUM Hesse.

HESSE, Phytium de Baryanum (1874) 34; SADEBECK, Stiz. Bot. ver. Brandeb. (1874) 116 (*P. esquiseti*); LOHDE, Uebe in paras Pilze (1874) 203 (*Lucidium pythiodes*); SMITH, Gard. Chron. **5** (1876) 656; SADEBECK, Tagebl. 49 Vers. deutsch. Naturf. u. Aerzte (1876) (*P. autumnale*); BERLESE and DE TONI, Syll. Fung. 7 (1888) 271 (excl. syn. *P. vexans*); ATKINSON, Bull. Cornell Exp. Sta. **94** (1895) (*Artotrogus*); BUTLER, Mem. Dept. Agr. India **1** (1907) No. 5, 86.

On *Camelia sativa, Lepidium sativum,* and *Ricinus communis*. Philip. Agr. & For. **5** (1916) 70.

On *Carica papaya, Lycopersicum esculentum,* and *Nicotiana tabacum*. Philip. Journ. Sci. **13** (1918) 166; Phytopath. **9** (1919) 30.

On *Oryza sativa*. Philip. Agr. **15** (1926) 290, 362.

PERONOSPORALES

PERONOSPORACEÆ

PHYTOPHTHORA COLOCASIAE Rac.

On *Colocasia esculentum* (*Colocasia antiquorum*). RACIBORSKI, Paras Alg. Pilze Javas **1** (1900) 9—Java; SYDOW and BUTLER, Ann. Myc. **5** (1907) 512; BUTLER and KULKARNI, Mem. Dept. Agr. India **5** (1913) No. 5, 233–259; MENDIOLA and ESPINO, Philip. Agr. & For. **5** (1916) 68—Los Baños; BAKER, Philip. Agr. & For. **5** (1917) 74; REINKING, Philip. Journ. Sci. **13** (1918) 167; REINKING, Phytopath. **9** (1919) 123; Philip. Agr. Rev. **18** (1925) 560; Philip. Agr. **14** (1925–26) 439.

PHYTOPHTHORA FABERI Maubl.

MAUBLANC, L'Agr. Prat. Pays Chauds No. 79 (1909) 315; COLEMAN, Ann. Myc. **8** (1910) 621 (*P. theobromae*).

On *Theobroma, Hevea*, and *Artocarpus*. SACCARDO and TROTTER, Syll. Fung. **21** (1912) 86.

On *Theobroma cacao* and *Carica papaya*. MENDIOLA and ESPINO, Philip. Agr. & For. **5** (1916) 66—Los Baños; BAKER, Philip. Agr. & For. **5** (1916) 77; REINKING, Philip. Journ. Sci. **13** (1918) 166.

On *Cocos nucifera*. REINKING, Philip. Journ. Sci. **14** (1919) 131; Journ. Agr. Res. **25** (1923) 267.

On *Citrus* spp. OCFEMIA and ROLDAN, Am. Journ. Bot. **14** (1927) 1.

PHYTOPHTHORA INFESTANS (Mont.) de Bary.

On *Lycopersicum esculentum*. Phytopath. **9** (1919) 127.

On *Solanum tuberosum*. Philip. Agr. & For. **5** (1916) 65; Philip. Journ. Sci. **13** (1918) 169, 361; Philip. Agr. **10** (1922) 348.

PHYTOPHTHORA MELONGENAE K. Sawada.

On *Solanum melingena*. Noji Shikenjo Tokubetsu Hokoku 2 (1915) 77–79; Mycologia **9** (1917) 249-253; Philip. Agr. **14** (1925) 317-328.

PHYTOPHTHORA PHASEOLI Thaxter.

On *Sandoricum koetjape* (*S. indicum*). CLARA, Philip. Journ. Sci. **35** (1928) 423.

SCLEROSPORA PHILIPPINENSIS Weston and SCHLEROSPORA SPONTANEA Weston. (Sclerospora maydis (Rac.) Butler.)

On *Zea mays*. RACIBORSKI, Ber. de Deutsch. Bot. Gessellsch. **15** (1897) 475 (*Peronospora*); SACCARDO and SYDOW, Syll. Fung. **14** (1899) 460 (*Peronospora*); BERLESE, Riv. Pat. Veg. **10** (1904) 219 (*Peronospora*); BUTLER, Mem. Dept. Agr. Ind. Bot. **5** (1913) No. 5, 275; BAKER, Philip. Agr. & For. **5** (1916) 78—Los Baños; Philip. Journ. Sci. **13** (1918) 131; Phytopath. **9** (1919) 139; Journ. Agr. Res. **19** (1920) 97; Philip. Agr. **8** (1920) 333; Journ. Agr. Res. **20** (1921) 678; Phytopath. **11** (1921) 372; Journ. Agr. Res. **20** (1921) 559; **23**: 276, 726; Philip. Agr. **15** (1926) 127.

SCLEROSPORA SACCHARI Miyake.

On *Saccharum officinarum*. Phytopath. **11** (1921) 371.

ZYGOMYCETES

MYCORALES

MUCORACEÆ

RHIZOPUS ARTOCARPI Rac.

On *Artocarpus integra* (*Artocarpus integrifolia*). BAKER, Philip. Agr. & For. 3 (1914) 158; Philip. Journ. Sci. 13 (1918) 361; REINKING, Philip. Journ. Sci. 13 (1918) 131; Philip. Agr. 12 (1923-24) 465.

On *Artocarpus communis*. REINKING, Philip. Journ. Sci. 13 (1918) 131; Phytopath. 9 (1919) 116.

On *Artocarpus incisa*. REINKING, Phytopath. 9 (1919) 116.

RHIZOPUS NIGRICANS Ehrenberg.

On fiber of *Musa textilis*. Philip. Journ. Sci. 32 (1927) 79.

PILOBOLACEÆ

PILOBOLUS LENTIGER Cda.

CORDA, Icon. Fung. 1 (1837) 22; SACCARDO, Syll. Fung. 7 (1837) 188, GROVE, Journ. Bot. (1884) 132 (*P. kleinii* var. *sphaerospora*).

On horse dung. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 25—Los Baños (*Baker 3892*).

FUNGI IMPERFECTI

SPHAERIOPSIDALES

SPHAERIOIDACEÆ

ASTEROMA PHASEOLI Brun.

SACCARDO, Syll. Fung. 10 (1916) 219.

On pods of *Phaseolus vulgaris*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 25—Los Baños (*Baker 3728*); BAKER, Philip. Agr. & For. 5 (1916) 76; REINKING, Philip. Journ. Sci. 13 (1916) 166; Phytopath. 9 (1919) 132.

BAKEROPHOMA SACCHARI Diedicke.

On *Saccharum officinarum*. BAKER, Philip. Agr. & For. 5 (1916) 76—Los Baños; DIEDICKE, Ann. Myc. 14 (1916) 62; REINKING, Philip. Journ. Sci. 13 (1918) 166; Philip. Agr. Rev. 11 (1918) 275; Phytopath. 9 (1919) 134; Philip. Agr. Rev. 14 (1921) 430.

BOTRYODIPLODIA ANCEPS Sacc. and Syd.

On *Morus alba*. BAKER, Philip. Agr. & For. 3 (1914) 162; Ann. Myc. 15 (1917) 28; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 128.

BOTRYODIPLODIA CURTA Sacc.

On *Ricinus communis*. Ann. Myc. 15 (1917) 258.

CONIOTHYRIUM COFFEAE Henn.

On *Coffea arabica*. BAKER, Philip. Agr. & For. 3 (1914) 160; REINKING, Phytopath. 9 (1919) 122.

On *Coffea* spp. REINKING, Philip. Journ. Sci. 13 (1918) 166.

CYTOSPORA ABERRANS Sacc.

On *Citrus nobilis.* BAKER, Philip. Agr. & For. 3 (1914) 160; REINKING, Philip. Journ. Sci. 13 (1918) 166.
On *Citrus* sp. Ann. Myc. 15 (1917) 256.
On coccids. REINKING, Phytopath. 9 (1919) 119.

CYTOSPORA PALMICOLA B. and Cke.

On *Cocos nucifera.* Ann. Myc. 15 (1917) 256; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 122.

DIPLODIA ARTOCARPI Sacc.

BAKER, Philip. Agr. & For. 3 (1914) 158.
On *Artocarpus communis.* REINKING, Philip. Journ. Sci. 13 (1918) 166.
On *Artocarpus incisa.* REINKING, Phytopath. 9 (1919) 116.

DIPLODIA ARTOCARPINA Sacc.

On *Artocarpus integra* (*A. integrifolia*). BAKER, Philip. Agr. & For. 3 (1914) 158; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 116.

DIPLODIA CARICAE Sacc.

On *Carica papaya.* BAKER, Philip. Agr. & For. 3 (1914) 159; Ann. Myc. 15 (1917) 257; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 118.

DIPLODIA CIRCINANS B. and Br.

On *Yucca aloifolia.* Ann. Myc. 15 (1917) 257.

DIPLODIA COCOCARPA Sacc.

On *Cocos nucifera.* BAKER, Philip. Agr. & For. 3 (1914) 160; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 122.

DIPLODIA COCOCARPA var. MALACCENSIS Tassi.

On *Cocos nucifera.* REINKING, Philip. Journ. Sci. 13 (1918) 166.

DIPLODIA CREBRA Sacc.

On fruits of *Musa sapientum.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 28—Los Baños (*Baker 3743*, err. *3745*); BAKER, Philip. Agr. & For. 5 (1916) 75; REINKING, Philip. Journ. Sci. 13 (1918) 168.
On *Musa* sp. REINKING, Phytopath. 9 (1919) 127.

DIPLODIA DATURAE Sacc.

On *Datura alba.* Ann. Myc. 15 (1917) 257.

DIPLODIA DURIONIS Sacc. and Syd.

On *Durio zibethinus.* BAKER, Philip. Agr. & For. 3 (1914) 161.

DIPLODIA MANIHOTI Sacc.

On *Manihot utilissima.* BAKER, Philip. Agr. & For. 3 (1914) 162; SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 28—Los Baños (*Baker 3888*); REINKING, Philip. Journ. Sci. 13 (1918) 168; Phytopath. 9 (1919) 128.

DIPLODIA MORI West.

SACCARDO, Syll. Fung. 3: 351.

On *Morus alba*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 28—Los Baños (*Baker 3818*); BAKER, Philip. Agr. & For. 5 (1916) 75; Ann. Myc. 15 (1917) 257; REINKING, Philip. Journ. Sci. 13 (1918) 168; Phytopath. 9 (1919) 128.

DIPLODIA PHASEOLINA Sacc.

On *Phaseolus lunatus*. BAKER, Philip. Agr. & For. 3 (1914) 163; Ann. Myc. 15 (1917) 257.

On *Phaseolus vulgaris*. BAKER, Philip. Agr. & For. 5 (1916) 76—Los Baños; REINKING, Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 132.

DIPLODIA RICINICOLA Sacc.

On *Ricinus communis*. Ann. Myc. 15 (1917) 257.

DIPLODIA SYNEDRELLAE Sacc.

On *Synedrella nodiflora*.

DIPLODINA DEGENERANS Diedicke.

On *Solanum melongena*. BAKER, Philip. Agr. & For. 5 (1916) 77—Los Baños; Ann. Myc. 14 (1916) 64.

HAPLOSPORA MANILENSIS Sacc.

On *Ricinus communis*. Ann. Myc. 15 (1917) 257.

DOTHIORELLA CRASTOPHILA Sacc.

On *Bambusa*. Ann. Myc. 15 (1917) 257.

LASIODIPLODIA THEOBROMAE (Pat.) Griff. and Maubl.

On *Theobroma cacao*. BAKER, Philip. Agr. & For. 3 (1914) 164; 4 (1915) 164; SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 28—Los Baños (*Baker 2729a, 2778*); Philip. Agr. & For. 5 (1916) 77; Ann. Myc. 15 (1917) 258; REINKING, Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 138; Philip. Agr. 8 (1920) 237.

On *Ipomoea batatas*. BAKER, Philip. Agr. & For. 5 (1916) 77—Los Baños.

On *Carica papaya*, *Citrus maxima*, and *Dioscorea esculenta*. REINKING, Philip. Journ. Sci. 13 (1918) 166.

On *Hevea brasiliensis*. Ann. Myc. 21 (1923) 105.

MACROPHOMA ARENGAE Sacc.

On *Arenga saccharifera*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 27—Los Baños (*Baker 2827*).

MACROPHOMA CYANOPSIDIS Syd.

On *Cyanopsis psoraleoides*. BAKER, Philip. Agr. & For. 3 (1914) 161.

MACROPHOMA MUSAE (Cke.) Berl. and Vogl. (Phoma musae Carpenter.)

On *Musa sapientum*. BAKER, Philip. Agr. & For. 3 (1914) 162; Ann. Myc. 15 (1917) 256; Philip. Agr. Rev. 14 (1921) 425; Phytopath.

12 (1922) 101; Ann. Myc. 21 (1923) 105; Philip. Agr. Rev. 18 (1925) 582; Philip. Agr. 15 (1926) 469.

On *Musa paradisiaca sapientum.* REINKING, Phytopath. 9 (1919) 128.

On *Musa textilis.* REINKING, Philip. Journ. Sci. 13 (1918) 168.

MACROPHOMA OBSOLETA Sacc.

On *Capparis horrida.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 26.

MACROPHOMA TRICHOSANTHIS Syd.

On *Trichosanthes anguina.* BAKER, Philip. Agr. & For. 5 (1916) 77—Los Baños.

On *Cucumis sativus.* Phytopath. 9 (1919) 124.

MICRODIPLODIA PASSERINIANA (Thüm.) Allesch.

SACCARDO, Syll. Fung. 3: 371.

On *Arenga saccharifera.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 28—Los Baños (*Baker 3866*); BAKER, Philip. Agr. & For. 5 (1916) 74.

APHYSA DESMODII Syd. (= Pazschkiella philippinensis Yates.)

On *Desmodium sinuosum.* Ann. Myc. 15 (1917) 205; 20 (1922) 73; 21 (1923) 99; 26 (1928) 435.

On *Dunbaria* sp. Philip. Journ. Sci. 13 (1918) 380.

PHOMA BAKERIANA Sacc.

On *Vigna* spp. Philip. Agr. & For. 4 (1914) 164; REINKING, Philip. Journ. Sci. 13 (1918) 170; Phytopath. 9 (1919) 139.

PHOMA CITRICARPA McAlpine.

On *Citrus* spp. Philip. Journ. Sci. 17 (1920) 640.

PHOMOPSIS CALANTHES Sacc.

On *Calanthes.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 27—Mount Maquiling (*Baker 3824*).

PHOMOPSIS CAPSICI (Magnaghi) Sacc.

SACCARDO, Syll. Fung. 18: 256.

On *Capsicum annuum.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 27—Los Baños (*Baker 3749*); BAKER, Philip. Agr. & For. 5 (1916) 74; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 117.

PHOMOPSIS CINERESCENS (Sacc.) Bubák.

On *Ficus* sp. Ann. Myc. 15 (1917) 256.

PHOMOPSIS DIOSCOREAE Sacc.

On *Dioscorea esculenta.* REINKING, Philip. Journ. Sci. 13 (1918) 167.

PHOMOPSIS GLIRICIDIAE Syd.

On *Gliricidia maculata.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 27—Los Baños (*Baker 3820*).

PHOMOPSIS PALMICOLA (Wint.) Sacc. f. ARECAE Sacc.

On *Areca catechu.* SACCARDO, Ann. Myc. 13 (1915) 128—Los Baños (*Raimundo,* comm. *Baker 2953*); BAKER, Philip. Agr. & For. 5 (1916) 73—Los Baños; REINKING, Philip. Journ. Sci. 13 (1918) 165.

PHOMA HERBARUM Westd.

On *Manihot utilissima.* REINKING, Philip. Journ. Sci. 13 (1918) 168.

PHOMA OLERACEA Sacc.

On *Dioscorea* spp. BAKER, Philip. Agr. & For. 3 (1914) 161; REINKING, Phytopath. 9 (1919) 124.

On *Dioscorea esculenta.* REINKING, Philip. Journ. Sci. 13 (1918) 167.

PHOMA SABDARIFFAE Sacc.

On *Hibiscus sabdariffa.* BAKER, Philip. Agr. & For. 4 (1914) 161; Ann. Myc. 15 (1917) 256; REINKING, Philip. Journ. Sci. 13 (1918) 167; Phytopath. 9 (1919) 126.

PHOMA SESAMINA Sacc.

On *Sesamum orientale* (*S. indicum*). BAKER, Philip. Agr. & For. 3 (1914) 164; REINKING, Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 136.

PHOMA SOLANOPHILA Oud.

SACCARDO, Syll. Fung. 16: 870.

On *Solanum melongena.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 27—Los Baños (*Baker 3825*); REINKING, Philip. Journ. Sci. 13 (1918) 169.

PHELLOSTROMA HYPOXYLOIDES Syd.

On *Areca catechu.* Philip. Agr. & For. 4 (1914) 158; Philip. Journ. Sci. 13 (1918) 165.

PHOMOPSIS ARECAE Syd.

On *Areca catechu.* BAKER, Philip. Journ. Agr. & For. 4 (1914) 158; REINKING, Philip. Journ. Sci. 13 (1918) 165.

PHYLLOSTICTA CIRCUMSEPTA Sacc.

On *Citrus nobilis.* BAKER, Philip. Agr. & For. 3 (1914) 160.

On *Citrus maxima.* REINKING, Philip. Journ. Sci. 13 (1918) 166.

On *Citrus* spp. REINKING, Phytopath. 9 (1919) 120; Philip. Agr. 9 (1920–21) 135.

PHYLLOSTICTA COCOPHYLLA Pass.

On *Cocos nucifera.* REINKING, Philip. Journ. Sci. 13 (1918) 167; Phytopath. 9 (1919) 122.

PHYLLOSTICTA DENSISSIMA Sacc.

On *Capparis horrida.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 26—Los Baños (*Baker 3787a*).

PHYLLOSTICTA DYSOXYLI Sacc.

On *Dysoxylum.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 26—Mount Maquiling (*Baker 3795*).

PHYLLOSTICTA EUCHLAENAE Sacc.

On *Euchlaena luxurians*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 25—Los Baños (*Baker 3734*); BAKER, Philip. Agr. & For. **5** (1916) 75.

PHYLLOSTICTA GLUMARUM Sacc.

On *Oryza sativa*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 25—Los Baños (*Baker 3871*, err. *3371*); BAKER, Philip. Agr. & For. **5** (1916) 75; Ann. Myc. **15** (1917) 256; REINKING, Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 131.

PHYLLOSTICTA GRAFFIANA Sacc.

On *Dioscorea aculeata*. Ann. Myc. **15** (1917) 255.

On *Dioscorea esculenta*. REINKING, Philip. Journ. Sci. **13** (1918) 167, 381.

PHYLLOSTICTA INSULARUM Sacc.

On *Anona muricata*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 26—Los Baños (*Baker 3795*); BAKER, Philip. Agr. & For. **5** (1916) 73; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 115.

PHYLLOSTICTA MANHOTICOLA Syd.

On *Manihot dichotoma*. BAKER, Philip. Agr. & For. **3** (1914) 162; REINKING, Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 127.

PHYLLOSTICTA MIURAI I. Miyake.

SACCARDO, Syll. Fung. 22: 864.

On *Oryza sativa*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 26—Los Baños (*Baker 3811*); BAKER, Philip. Agr. & For. 5 (1916) 75; Philip. Journ. Sci. **13** (1918) 381; REINKING, Philip. Journ. Sci. **13** (1918) 168; Phytopath. **9** (1919) 131.

PLACOSPHAERIA DURIONIS Syd.

On *Durio zibethinus*. BAKER, Philip. Agr. & For. **3** (1914) 161.

PLACOSPHAERIA TIGLII Henn.

On *Croton tiglium*. BAKER, Philip. Agr. & For. **4** (1914) 161; Ann. Myc. **15** (1917) 256; Philip. Journ. Sci. **13** (1918) 381.

RHABDOSPORA SYNEDRELLAE Sacc.

On dead stems of *Synedrella nodiflora*. SACCARDO, Ann. Myc. **13** (1915) 128—Los Baños (*Baker 3228*).

SEPTORIA PALMARUM Sacc.

On *Corypha elata*. BAKER, Philip. Agr. & For. **3** (1914) 160.

SEPTOSPORIELLA PHILIPPINENSIS Sacc.

On *Saccharum spontaneum*. SACCARDO, Syll. Fung. **3** (1916) 29—Los Baños (*Baker 3742*).

STAGONOSPORA VARIANS Sacc.

On *Symplocum whitfordii*. Ann. Myc. **15** (1917) 259.

TRAVERSOA DOTHIORELLOIDES Sacc. and Syd.

On *Morus alba.* BAKER, Philip. Agr. & For. **3** (1914) 162; REINKING, Philip. Journ. Sci. **13** (1918) 166; Phytopath. **9** (1919) 128.

On *Citrus nobilis.* Ann. Myc. **15** (1917) 257.

TRAVERSOA EXCIPULOIDES Sacc.

Ann. Myc. **15** (1917) 257.

TRAVERSOA EXCIPULOIDES Sacc. and Syd. var. **DISTANS** Sacc. and Syd.

On *Gliricidia sepium.* Ann. Myc. **15** (1917) 257.

VERMICULARIA BREVISETA Sacc.

On *Synedrella nodiflora.* Ann. Myc. **15** (1917) 267.

VERMICULARIA CAPSICI Syd.

On *Capsicum annuum.* REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 117.

VERMICULARIA FALLAX Sacc.

On *Passiflora quadrangularis.* BAKER, Philip. Agr. & For. **3** (1914) 163.

VERMICULARIA HORRIDULA Sacc.

On *Dolichos uniflorus.* BAKER, Philip. Agr. & For. **3** (1914) 161; REINKING, Phytopath. **9** (1919) 132.

On *Dolichos lablab.* REINKING, Philip. Journ. Sci. **13** (1918) 167.

VERMICULARIA MERRILLIANA Sacc.

On *Datura alba.* Ann. Myc. **15** (1917) 267.

VERMICULARIA SESAMINA Sacc.

On *Sesamum orientale* (*S. indicum*). REINKING, Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 136.

VERMICULARIA XANTHOSOMATIS Sacc.

On *Xanthosoma sagittifolium.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 28—Los Baños (*Baker 3750*); BAKER, Philip. Agr. & For. **5** (1916) 78; REINKING, Phytopath. **9** (1919) 139.

YPSILONIA CUSPIDATA Léveille.

On leaves on one of the Anonaceæ. LÉVEILLE, Ann. Sci. Nat. (1846) 284—Manila (*Cuming*); SACCARDO, Syll. Fung. **3** (1884) 216.

On *Cyclostemon* sp. Ann. Myc. **15** (1917) 261.

NECTRIOIDACEÆ

ASCHERSONIA CINNABARINA P. Henn.

On *Astronia.* Ann. Myc. **15** (1917) 261.

ASCHERSONIA CONFLUENS Henn.

HENNINGS, Monsunia **1** (1899) 37; Hedwigia 145 (1902) (*A. phthurioides*); BAKER, Leafl. Philip. Bot. **6** (1914) 2155; PETCH, Ann. Roy. Bot. Gard. Peradeniya **5** (1914) 526 (stage of *Hypocrella mollii* Koord.).

ASCHERSONIA LECANIOIDES P. Henn.

On *Melastoma*. Ann. Myc. 15 (1917) 261.

ASCHERSONIA PARAENSIS Henn.

SACCARDO, Syll. Fung. 18: 413.

On coccids on *Psidium guajava*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 29—Hills back of Paete, Laguna Province (*Baker 3790*); BAKER, Philip. Agr. & For. 5 (1916) 76; REINKING, Phytopath. 9 (1919) 133.

ASCHERSONIA PLACENTA B. and Br.

BERKELEY and BROOME, Journ. Linn. Soc. Bot. 14 (1873) 89; HENNINGS, Engl. Bot. Jahrb. 25 (1898) 509 (*A. novo-guineensis*); PENZIG and SACCARDO, Malpighia (1901) 236 (*A. javanica*); HENNINGS, Hedwigia (1902) 145 (*A. lecanioides*); BAKER, Leafl. Philip. Bot. 6 (1914) 2155 (*A. lecanioides* and *A. novoguineensis*); PETCH, Ann. Roy. Bot. Gard. Peradeniya 5 (1914) 527.

ASCHERSONIA SAMOENSIS Henn.

HENNINGS, Engler's Bot. Jahrb. 23 (1896) 289; Monsunia 1 (1899) 37 (*A. cinnabarina*); PATOUILLARD and HARIOT, Bull. Soc. Myc. Fr. 20 (1904) 65 (*A. napoleonae*); BAKER, Leafl. Philip. Bot. 6 (1914) 2154 (*A. cinnabarina*); PETCH, Ann. Roy. Bot. Gard. Peradeniya 5 (1914) 526 [stage of *Hypocrella discoidea* (B. and Br.) Sacc.].

ASCHERSONIA SCLEROTOIDES Henn.

HENNINGS, Hedwigia (1902) 146; PATOUILLARD, Bull. Soc. Myc. Fr. 22 (1906) 59 (*A. pisiformis*); BAKER, Leafl. Philip. Bot. 7 (1914) 2514; PETCH, Ann. Roy. Bot. Gard. Peradeniya 5 (1914) 525 (stage of *Hypocrella reineckiana* Henn.).

On *Citrus* sp. Ann. Myc. 15 (1917) 261.

On *Citrus maxima*. REINKING, Philip. Journ. Sci. 13 (1918) 165.

On coccids. REINKING, Phytopath. 9 (1919) 119.

LEPTOSTROMATACEÆ

DIEDICKEA SINGULARIS Syd.

On *Polyosma philippinensis*. Ann. Myc. 15 (1917) 260.

On *Polyosma sorsogonensis*. Leafl. Philip. Bot. 9 (1925) 3137.

LASIOTHYRIUM CYCLOSCHIZON Syd.

On *Aegiceras corniculatum*. Philip. Journ. Sci. 12 (1917).

LEPTOTHYRIUM CIRCUMSCISSUM Syd.

On *Mangifera indica*. BAKER, Philip. Agr. & For. 3 (1914) 162; REINKING, Philip. Journ. Sci. 13 (1918) 168; Phytopath. 9 (1919) 127.

MELANCONIALES

MELANCONIACEÆ

COLLETOTRICHUM ARECAE Sydow.

On *Areca catechu*. BAKER, Philip. Agr. & For. 4 (1914) 158; REINKING, Philip. Journ. Sci. 13 (1918) 165.

COLLETOTRICHUM ARECAE Syd. Forma setis perpaucis praedita.

On *Areca catechu*. Ann. Myc. 15 (1917) 262.

COLLETOTRICHUM EUCHROUM Syd.

On *Euphorbia neriifolia*. BAKER, Philip. Agr. & For. 3 (1914) 161.

COLLETOTRICHUM FALCATUM Went.

On *Saccharum officinarum*. Phytopath. 9 (1919) 134; Philip. Agr. Rev. 14 (1921) 431.

COLLETOTRICHUM GLOEOSPORIOIDES Penz.

On *Citrus maxima*. Philip. Journ. Sci. 13 (1918) 166; Philip. Agr. 9 (1920–21) 139; Philip. Agr. Rev. 14 (1921) 424.

COLLETOTRICHUM LUSSONIENSE Sacc.

On *Manihot utilissima*. BAKER, Philip. Agr. & For. 3 (1914) 162; REINKING, Philip. Journ. Sci. 13 (1918) 168; Phytopath. 9 (1919) 128.

COLLETOTRICHUM NIGRUM Ellis and Halsted.

On *Capsicum annuum*. Phytopath. 9 (1919) 117; Philip. Agr. 13 (1924–25) 165; 14 (1925–26) 500.

COLLETOTRICHUM PAPAYAE (Henn.) Syd.

On *Carica papaya*. BAKER, Philip. Agr. & For. 3 (1914) 159; Ann. Myc. 15 (1917) 262; REINKING, Philip. Journ. Sci. 13 (1918) 166; Phytopath. 9 (1919) 118; Ann. Myc. 21 (1923) 105.

GLOEOSPORIUM MACROPHOMOIDES Sacc.

On *Sesamum indicum*. BAKER, Philip. Agr. & For. 3 (1914) 164.

GLOEOSPORIUM AFFINE Sacc.

SACCARDO, Syll. Fung. 3: 709.

On *Hoya*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 29—Los Baños (*Baker 3895*).

GLOEOSPORIUM ALCHORNEAE Syd.

On *Alchornea javanica*. Ann. Myc. 15 (1917) 261.

On *Alchornea rugosa*. Leafl. Philip. Bot. 9 (1925) 3138.

GLOEOSPORIUM ALSTONIAE Sacc.

On *Alstonia scholaris*. SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 29—Los Baños (*Baker 3739*).

GLOEOSPORIUM CANAVALIAE Syd.

On *Canavalia*. BAKER, Philip. Agr. & For. 3 (1914) 159.

On *Canavalia gladiata*. REINKING, Philip. Journ. Sci. 13 (1918) 166.

On *Phaseolus* spp. REINKING, Phytopath. 9 (1919) 132.

GLOEOSPORIUM CATECHU Syd.

On *Areca catechu*. BAKER, Philip. Agr. & For. 3 (1914) 158; REINKING, Philip. Journ. Sci. 13 (1918) 165.

GLOEOSPORIUM LEBBEK Syd.

On *Albizzia lebbek*. Ann. Myc. 15 (1917) 261.

GLOEOSPORIUM MACROPHOMOIDES Sacc.

On *Sesamum orientale* (*Sesamum indicum*). BAKER, Philip. Agr. & For. 4 (1914) 164; REINKING, Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 136.

On *Dioscorea esculenta.* REINKING, Philip. Journ. Sci. 13 (1918) 166.

GLOEOSPORIUM MUSARUM Cke. and Mass.

On *Musa sapientum.* Philip. Agr. 10 (1922) 419; Philip. Agr. Rev. 18 (1925) 581; Philip. Agr. 13 (1924–25) 340.

GLOEOSPORIUM PALMARUM Oud.

On *Areca catechu.* REINKING, Philip. Journ. Sci. 13 (1918) 165.

GLOEOSPORIUM VANILLAE Cke.

On Orchidaceæ. BAKER, Philip. Agr. & For. 3 (1914) 163.

On *Vanilla* sp. Ann. Myc. 15 (1917) 261.

MARSONIA PAVONINA Syd.

On *Macaranga* sp. Ann. Myc. 15 (1917) 262.

On *Macaranga utilis.* Leafl. Philip. Bot. 9 (1925) 3138.

MELANCONIUM SACCHARI Cooke.

SACCARDO, Syll. Fung. 14: 1019.

On *Saccharum officinarum.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 29—Ube, Mount Banahao (*Baker 4293*, err. *3867*); BAKER, Philip. Agr. & For. 5 (1916) 76, 343; Philip. Agr. Rev. 11 (1918) 276; REINKING, Philip. Journ. Sci. 13 (1918) 169; Phytopath. 9 (1919) 134; Philip. Agr. Rev. 14 (1921) 429.

On *Saccharum spontaneum.* Ann. Myc. 15 (1917) 262.

PESTALOZZIA FUNEREA Desm.

On *Carissa arduina.* BAKER, Philip. Agr. & For. 3 (1914) 162; 5 (1916) 74—Los Baños; SACCARDO, Syll. Fung. 3 (1916) 791; Nuovo Giorn. Bot. Ital. 23 (1916) 29—Los Baños (*Baker 3788, 3894*).

PESTALOZZIA PALMARUM Cke. and Grev.

On *Areca catechu.* BAKER, Philip. Agr. & For. 3 (1914) 160; 5 (1916) 73—Los Baños; SACCARDO, Syll. Fung. 3 (1916) 796; Nuovo Giorn. Bot. Ital. 23 (1916) 30—Los Baños (*Baker 3814*).

On *Cocos nucifera.* Ann. Myc. 15 (1917) 262; REINKING, Phytopath. 9 (1919) 121; Philip. Agr. Rev. 14 (1921) 428; 18 (1925) 591.

PESTALOZZIA PAUCISETA Sacc.

On *Uvaria.* Ann. Myc. 15 (1917) 262.

On *Mangifera indica.* REINKING, Philip. Journ. Sci. 13 (1918) 167.

SEPTOGLOEUM ARACHIDIS Rac.

On *Arachis hypogaea.* REINKING, Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 116.

HYPHALES

MUCEDINACEÆ

ASPERGILLUS DELACRIOIXI Sacc. and Syd.

On *Theobroma cacao.* BAKER, Philip. Agr. & For. **3** (1914) 164; **4** (1915) 165; REINKING, Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 138.

ASPERGILLUS FLAVUS Link.

On fiber of *Musa textilis.* Philip. Journ. Sci. **32** (1927) 79.

ASPERGILLUS PERICONIOIDES Sacc.

On *Carica papaya.* BAKER, Philip. Agr. & For. **3** (1914) 159; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 118.

MYCOGNE CERVINA Ditm. var. THEOBROMAE Sacc.

On *Theobroma cacao.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 30—Los Baños (*Baker 3884*); BAKER, Philip. Agr. & For. **5** (1916) 77; REINKING, Philip. Journ. Sci. **13** (1918) 169; Phytopath. **9** (1919) 138.

OIDIUM ERYSIPHOIDES Fr.

On *Heliotropus indicus.* Ann. Myc. **15** (1917) 263.

OOSPORA CANDIDULA Sacc.

SACCARDO, Syll. Fung. **4**: 12.

On *Theobroma cacao.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 30—Los Baños (*Baker 3729b*); BAKER, Philip. Agr. & For. **5** (1916) 77; REINKING, Philip. Journ. Sci. **13** (1918) 245; Phytopath. **9** (1919) 138.

OOSPORA HYALINULA Sacc. var. SORDIDULA Sacc.

On *Capparis horrida.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 30—Los Baños (*Baker 3787d,* err. *3887*).

OOSPORA ORYZETORUM Sacc.

On *Oryza sativa.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 30—Los Baños (*Baker 3867*); BAKER, Philip. Agr. & For. **5** (1916) 75; REINKING, Philip. Journ. Sci. **13** (1918) 228; Phytopath. **9** (1919) 131.

RAMULARIA CATAPPAE Rac.

On *Terminalia catappa.* BAKER, Philip. Agr. & For. **3** (1914) 164; REINKING, Phytopath. **9** (1919) 138.

DEMATIACEÆ

CERCOSPORA ACEROSUM Dickh. and Hein.

On *Saccharum officinarum.* BAKER, Philip. Agr. & For. **4** (1914) 164.

CERCOSPORA APII Fres.

On *Apium graveolens.* Ann. Myc. **15** (1917) 264; Philip. Journ. Sci. **13** (1918) 165; Philip. Agr. **10** (1922) 349.

CERCOSPORA ARMORACIAE Sacc.

On *Brassica* spp. BAKER, Philip. Agr. & For. **3** (1914) 159.

On *Brassica pekinensis*. REINKING, Philip. Journ. Sci. **13** (1918) 165.

On *Brassica chinensis*. REINKING, Phytopath. **9** (1919) 117.

CERCOSPORA ARTOCARPI Syd.

On *Artocarpus incisa*. BAKER, Philip. Agr. & For. **3** (1914) 158; REINKING, Phytopath. **9** (1919) 116.

On *Artocarpus communis*. REINKING, Philip. Journ. Sci. **13** (1918) 178.

CERCOSPORA OVERRHOI Welles.

On *Averrhoa carambola*. WELLES, Philip. Journ. Sci. **19** (1921) 749.

CERCOSPORA BAUHINIAE Syd.

On *Bauhinia malabarica*. Ann. Myc. **15** (1917) 264.

CERCOSPORA BETICOLA Sacc.

On *Beta vulgaris*. Phytopath. **9** (1919) 116; Philip. Agr. **10** (1922) 349.

CERCOSPORA BRASSICOLA Henn.

On *Brassica sinensis*. HENNINGS, Engl. Jahrb. **37** (1905) 166—Japan; SACCARDO and TROTTER, Syll. Fung. **22** (1913) 1413; Ann. Myc. **15** (1917) 264; REINKING, Phytopath. **9** (1919) 117.

On *Brassica pekinensis*. REINKING, Philip. Journ. Sci. **13** (1918) 165.

CERCOSPORA CANAVALIAE Syd.

On *Canavalia gladiata*. BAKER, Philip. Agr. & For. **3** (1914) 159; REINKING, Philip. Journ. Sci. **13** (1918) 165.

On *Phaseolus* sp. REINKING, Phytopath. **9** (1919) 132.

CERCOSPORA COFFEICOLA Berk. and Cooke.

On *Coffea* spp. WELLES, Philip. Journ. Sci. **19** (1921) 743.

CERCOSPORA CRUENTA Sacc.

On *Phaseolus aureus*. WELLES, Phytopath. **14** (1924) 357.

CERCOSPORA DUDDIAE Welles.

On *Allium sativum* and *A. cepa*. WELLES, Phytopath. **13** (1923) 364.

CERCOSPORA GLIRICIDIAE Syd.

On *Gliricidia sepium*. Ann. Myc. **15** (1917) 264; Philip. Journ. Sci. **12** (1917) 380; **13** (1918) 382.

CERCOSPORA HENNINGSII Allesch.

On *Manihot utilissima*. BAKER, Philip. Agr. & For. **4** (1914) 162; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 128.

CERCOSPORA LACTUCAE Stevenson. (Cercospora lactucae Welles.)

On *Lactuca sativa*. WELLES, Phytopath. **13** (1923) 289.

CERCOSPORA LITSEAE-GLUTINOSAE Syd.

On *Litsea glutinosa*. Ann. Myc. **15** (1917) 264.

CERCOSPORA LUSSONIENSE Sacc.

On *Phaseolus lunatus*. BAKER, Philip. Agr. & For. **3** (1914) 163.

On *Phaseolus* spp. REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 132.

CERCOSPORA MANGIFERAE Koord.

On *Mangifera indica*. BAKER, Philip. Agr. & For. **3** (1914) 162; Ann. Myc. **15** (1917) 264; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 127.

CERCOSPORA MANIHOTIS P. Henn.

On *Manihot utilissima*. Ann. Myc. **15** (1917) 265; REINKING, Philip. Journ. Sci. **13** (1918) 165; Ann. Myc. **21** (1923) 106.

CERCOSPORA MELONGENAE Welles.

On *Solanum melongena*. WELLES, Phytopath. **12** (1922) 63.

CERCOSPORA NICOTIANAE Ell. and Evht.

On *Nicotiana tabacum*. BAKER, Philip. Agr. & For. **3** (1914) 162; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 117; Ann. Myc. **21** (1923) 106; Philip. Agr. Rev. **18** (1925) 570; Philip. Agr. **15** (1926) 300.

CERCOSPORA OCCIDENTALIS Cke. var. CASSIOCARPA Sacc.

On *Cassia occidentale*. Ann. Myc. **15** (1917) 265.

CERCOSPORA PACHYDERMA Syd.

On *Dioscorea* spp. BAKER, Philip. Agr. & For. **4** (1914) 161; REINKING, Phytopath. **9** (1919) 124.

On *Dioscorea alata*. Ann. Myc. **15** (1917) 265.

On *Dioscorea esculenta*. REINKING, Philip. Journ. Sci. **13** (1918) 165.

CERCOSPORA PAHUDIAE Syd.

On *Pahudia romboidea*. BAKER, Philip. Agr. & For. **3** (1914) 163.

CERCOSPORA PANTOLEUCA Syd.

On *Clitoria ternatea*. BAKER, Philip. Agr. & For. **3** (1914) 160.

CERCOSPORA PERSONATA (B. and C.) Ell.

On *Arachis hypogaea*. BAKER, Philip. Agr. & For. **3** (1914) 158; Ann. Myc. **15** (1917) 265; Philip. Journ. Sci. **12** (1917) 380; REINKING, Phytopath. **9** (1919) 115.

CERCOSPORA PUERARIAE Syd.

On *Pueraria* sp. Ann. Myc. **15** (1917) 265.

CERCOSPORA SESAMI A. Zimm.

On *Sesamum orientale* (*S. indicum*). BAKER, Philip. Agr. & For. **3** (1914) 164; Philip. Agr. & For. **6** (1917) 294; Ann. Myc. **15** (1917) 265; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 136.

CERCOSPORA STIZOLOBII Syd.

On *Mucuna deeringiana* (*Stizolobium deeringianum*). BAKER, Philip. Agr. & For. **3** (1914) 164; REINKING, Philip. Journ. Sci. **13** (1918) 165.

On *Stizolobium niveum*. REINKING, Phytopath. **9** (1919) 132.

CERCOSPORA SUBSESSILIS Syd.

On *Melia azedarach.* Ann. Myc. 15 (1917) 265.

CERCOSPORA TIGLII Henn.

On *Croton tiglium.* BAKER, Philip. Agr. & For. 4 (1914) 161.

CERCOSPORA UBI Rac.

On *Dioscorea* spp. BAKER, Philip. Agr. & For. 3 (1914) 161; REINKING, Phytopath. 9 (1919) 124.

On *Dioscorea esculenta.* REINKING, Philip. Journ. Sci. 13 (1918) 165.

ALTERNARIA BRASSICAE (Berk.) Sacc.

On *Brassica culta.* Ann. Myc. 15 (1917) 266.

CERCOSPORINA CARTHAMI Syd.

On *Carthamus tinctorium.* BAKER, Philip. Agr. & For. 3 (1914) 159.

CLADOSPORIUM HERBARUM L.

On *Phaseolus lunatus.* BAKER, Philip. Agr. & For. 3 (1914) 163; REINKING, Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 132.

CLADOSPORIUM LINEOLATUM Sacc.

On *Capparis micracantha.* Ann. Myc. 15 (1917) 264.

CLASTEROSPORIUM MAYDICUM Sacc.

On *Zea mays.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 31—Los Baños (*Baker 3733a*); BAKER, Philip. Agr. & For. 5 (1916) 78; REINKING, Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 140.

CONIOSPORIUM BAMBUSAE (Thuem. and Bolle) Sacc.

On *Bambusa* sp. Ann. Myc. 15 (1917) 263.

On *Bambusa longinodis.* Ann. Myc. 21 (1923) 105.

CONIOSPORIUM EXTREMORUM Syd.

On *Saccharum officinarum.* BAKER, Philip. Agr. & For. 3 (1914) 164; 5 (1916) 343; Philip. Agr. Rev. 11 (1918) 276; REINKING, Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 136.

CONIOSPORIUM ORYZINUM Sacc.

On *Oryza sativa.* SACCARDO, Nuovo Giorn. Bot. Ital. 23 (1916) 31—Los Baños (*Baker 3773*); BAKER, Philip. Agr. & For. 5 (1916) 76; REINKING, Philip. Journ. Sci. 13 (1918) 165; Phytopath. 9 (1919) 131.

CONIOSPORIUM UNILATERALE Sacc. and Peyr.

On *Schizostachyum* sp. Ann. Myc. 15 (1917) 263.

CONIOSPORIUM VINOSUM (B. and C.) Sacc.

On *Saccharum officinarum.* BAKER, Philip. Agr. & For. 3 (1914) 164; 5 (1916) 343; REINKING, Philip. Journ. Sci. 13 (1918) 165; Philip. Agr. Rev. 11 (1918) 276; Phytopath. 9 (1919) 136.

DICHOTOMELLA AREOLATA Sacc.

On *Artocarpus integra* (*A. integrifolia*). BAKER, Philip. Agr. & For. **3** (1914) 158; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1916) 116.

HELMINTHOSPORIUM CARYOPSIDUM Sacc.

On *Andropogon sorghum* (*Sorghum vulgare, Holcus sorghum*). BAKER. Philip. Agr. & For. **3** (1914) 164; SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 32—Los Baños (*Baker 3754, 3808, 3812*); BAKER, Philip. Agr. & For. **5** (1916) 77; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 137.

HELMINTHOSPORIUM CURVULUM Sacc.

On *Zea mays*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 32—Los Baños (*Baker 3733b*); BAKER, Philip. Agr. & For. **5** (1916) 78; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 140.

HELMINTHOSPORIUM FICINUM Sacc. (Helminthosporium ficinum Yates.)

On *Ficus caudatifolia*. Philip. Journ. Sci. **13** (1918) 382; Ann. Myc. **20** (1922) 73.

On *Ficus*. Ann. Myc. **21** (1923) 105; Leafl. Philip. Bot. **9** (1925) 3138.

HELMINTHOSPORIUM INCONSPICUUM C. and Ell.

On *Zea mays*. Philip. Agr. Rev. **4** (1911) 357; BAKER, Philip. Agr. & For. **3** (1914) 164; Ann. Myc. **15** (1917) 265; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 140; Philip. Agr. **12** (1923–24) 457; Philip. Agr. Rev. **18** (1925) 571; Philip. Agr. **15** (1925) 127.

HELMINTHOSPORIUM INVERSUM Sacc.

On *Erythrina indica*. Ann. Myc. **15** (1917) 265.

HELMINTHOSPORIUM ORYZAE Breda de Haan.

On *Oryza sativa*. OCFEMIA, Phytopath. **12** (1922) 34; Am. Journ. Bot. **11** (1924) 437.

HELMINTHOSPORIUM PAPAYAE Syd.

On *Carica papaya*. SYDOW, Ann. Myc. **21** (1923) 105.

HELMINTHOSPORIUM RAVENELII Berk. and Curt.

On *Sporobolus elongatus*. Ann. Myc. **15** (1917) 266; **21** (1923) 105.

On *Panicum auritum*. Philip. Journ. Sci. **13** (1918) 383.

On *Sporobolus* sp. Leafl. Philip. Bot. **9** (1925) 3138.

HADRONEMA ORBICULARE Sydow.

On *Quercus* sp. Philip. Journ. Sci. **12** (1917) 380; **13** (1918) 382.

PERICONIA PHILIPPINENSIS Sacc.

On Panicum. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 32—Los Baños (*Baker 3766*).

SARCINELLA RAIMUNDOI Sacc.

On *Solanum melongena*. BAKER, Philip. Agr. & For. **3** (1914) 164; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 136.

SEPTONEMA PHILIPPINUM Sacc.

On *Imperata cylindrica.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 32—Los Baños (*Baker 3769*).

SPORODESMIUM BAKERI Syd.

On *Musa sapientum.* BAKER, Philip. Agr. & For. **3** (1914) 162; REINKING, Philip. Journ. Sci. **13** (1918) 165.

On *Musa paradisiaca sapientum.* REINKING, Phytopath. **9** (1919) 129.

TORULA DICHROA Sacc.

On *Saccharum spontaneum.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 31—Los Baños (*Baker 3737*).

TORULA HERBARUM Link.

SACCARDO, Syll. Fung. **4**: 256.

On *Capparis horrida.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 30—Los Baños (*Baker 3787c*).

TORULA HERBARUM Lk. f. **QUATERNELLA** Sacc.

On *Thunbergia grandiflora.* Ann. Myc. **15** (1917) 263.

TRICHOSPORIUM COCCIDICOLA Sacc.

On *Phenacuspis mischocarpi* and *Mischocarpus fuscescens.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 31—Mount Maquiling (*Baker 3859*).

STIGMELLA MANILENSIS Sacc.

On *Allophyllum dimorphum.* Ann. Myc. **15** (1917) 268.

ZYGOSPORIUM OSCHEOIDES Mont.

On *Areca catechu.* REINKING, Philip. Journ. Sci. **13** (1918) 165.

TUBERCULARIACEÆ

DENDRODOCHIUM LUSSONENSE Sacc.

Ann. Myc. **15** (1917) 267.

EXOSPORIUM DURUM Sacc.

On *Cocos nucifera.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 33—Ube, Mount Banahao (*Baker 3864*); BAKER, Philip. Agr. & For. **5** (1916) 74—Mount Banahao; REINKING, Philip. Journ. Sci. **13** (1918) 165; REINKING, Phytopath. **9** (1919) 121; Philip. Agr. Rev. **18** (1925) 591.

EXOSPORIUM PULCHELLUM Sacc.

On *Areca catechu.* SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 33—Los Baños (*Baker 3753, 3799*); BAKER, Philip. Agr. & For. **5** (1916) 73—Los Baños; REINKING, Philip. Journ. Sci. **13** (1918) 165.

On *Orania palindan.* Ann. Myc. **15** (1917) 266.

FUSARIUM CUBENSE Efs.

On *Musa sapientum.* Philip. Agr. Rev. **13** (1920) 128; Phytopath. **10** (1920) 504.

On *Musa textilis.* Philip. Agr. Rev. **16** (1923) 106; LEE and SERRANO, Phytopath. **13** (1923) 354; Philip. Agr. **19** (1930) 27.

FUSARIUM THEOBROMAE App. and Strunk.

SACCARDO, Syll. Fung. **18**: 672.

On *Theobroma cacao*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 33—Los Baños (*Baker 3885*); REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 138.

HYMENOPSIS CUDRANIAE Mass.

On *Cudrania javanica*. Philip. Journ. Sci. **13** (1918) 384.

HYMENULA COPELANDI Sacc.

On *Diospyrus* sp. Ann. Myc. **15** (1917) 267.

ILLOSPORIUM TABACINUM Sacc.

On *Macaranga*. SACCARDO, Ann. Myc. **13** (1915) 128—Los Baños (*Baker 3322*).

PIONNOTES CAPILLACEA Sacc.

On *Persea americana* and *P. gratissima*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 34—Los Baños (*Baker 3816*); BAKER, Philip. Agr. & For. **5** (1916) 76.

SPEGAZZINIA MELIOLAE A. Zimm.

On *Meliola callicarpae*. Philip. Journ. Sci. **12** (1916) 363; Ann. Myc. **15** (1917) 268.

SPEGAZZINIA ORNATA Sacc.

SACCARDO, Syll. Fung. **4** (1917) 758.

On *Oryza sativa*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 32—Los Baños (*Baker 3772, 3770, 3803*); BAKER, Philip. Agr. & For. **5** (1916) 76—Los Baños; REINKING, Philip. Journ. Sci. **13** (1918) 165; Phytopath. **9** (1919) 131.

GRAPHIOLA ARENGAE Rac.

On *Arenga ambong*. Ann. Myc. **15** (1917) 178.

GRAPHIOLA CYLINDROSPORA Syd.

On *Livistonia*. Philip. Agr. & For. **5** (1916) 74.

MYCELIA STERILIA

OZONIUM GLUMICOLA Sacc.

On *Schizostachum acutiflorum*. SACCARDO, Nuovo Giorn. Bot. Ital. **23** (1916) 34—Mount Maquiling (*Baker 3813*).

SCLEROTIUM ROLFSII Sacc.

On *Nicotiana tabacum*. Philip. Agr. Rev. **14** (1921) 427; Philip. Agr. **15** (1926) 290.

On *Lycopersicum esculentum* and *Capsicum annuum*. Philip. Agr. **13** (1924–25) 166; **15** (1926) 580.

On seedlings. Philip. Agr. Rev. **18** (1925) 564.

On *Oryza sativa*. Philip. Agr. **15** (1926) 362; Philip. Agr. Rev. **19** (1926) 238.

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WORM PARASITES OF THE BROWN RAT (MUS NORVEGICUS) IN THE PHILIPPINE ISLANDS, WITH SPECIAL REFERENCE TO THOSE FORMS THAT MAY BE TRANSMITTED TO HUMAN BEINGS

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NINETEEN TEXT FIGURES

INTRODUCTION

The rôle of rats as carriers and reservoirs of bubonic plague and other bacterial as well as spirochætal infections, has long been well recognized. For this reason various antirat measures have been in vogue in different parts of the world, especially in seaports, for the control and prevention of these diseases. The fact, however, that these animals are often infested with certain parasitic worms that are also a menace to human health, is not so well known. For this reason and because of the fact that the helminthic fauna of rats in the Philippine Islands has never been studied to any great extent, it seemed worth while to undertake a systematic examination of these animals in order to determine their parasites and to find if they harbor forms that are transmissible to man.

RATS EXAMINED AND THE INCIDENCE OF INFESTATION

The survey was limited to the brown or Norway rat, *Mus norvegicus* Erxleben, 1777 (= *M. decumanus* Pallas, 1778), since this was the only rat constantly available in large numbers. A total of nine hundred fifty of these rodents were dissected

during the period from May 7, 1930, to January 14, 1931. They were trapped in the different sections of the City of Manila and were among those sent to the Bureau of Science by the Philippine Health Service for routine bubonic-plague inspection. A list of the different parasites encountered and their incidence are given in Table 1. One species of roundworm, *Syphacia obvelata,* is not represented in the table, but it is believed to infest rats in the Philippines in view of its having been reported by Riley (1919) in a child residing in Zamboanga, Mindanao.

With the exception of the flukes, a new species of the cestode genus *Raillietina,* and a new nematode in the genus *Rictularia,* all of which are apparently restricted to the Philippines in their distribution, the different worms collected have been reported from other countries. The following were the most commonly met with in the order they are named: The larval form of *Tænia tæniaformis* (commonly known as *Cysticercus fasciolaris*), *Hepaticola hepatica, Raillietina garrisoni* sp. nov., *Strongyloides ratti, Hymenolepis diminuta, Nippostrongylus muris, Trichosomoides crassicauda,* and *Gongylonema neoplasticum. Hymenolepis nana* and *Heterakis spumosa,* which are common in rats in many countries, were rarely encountered. *Trichinella spiralis,* the most dangerous worm of rats from the public-health standpoint, was not found at all.

TABLE 1.—*Parasites encountered in nine hundred fifty rats.*

Name of parasites.	Infestation. Per cent.
Trematodes:	
Euparyphium ilocanum	0.5
Euparyphium guerreroi	0.1
Euparyphium murinum sp. nov.	0.1
Cestodes:	
Tænia tæniaformis (larval form)	94.0
Raillietina garrisoni sp. nov.	86.0
Hymenolepis diminuta	64.0
Hymenolepis nana	1.7
Nematodes:	
Gongylonema neoplasticum	44.0
Hepaticola hepatica	90.0
Heterakis spumosa	0.4
Nippostrongylus muris	58.0
Protospirura muricola	1.3
Rictularia whartoni sp. nov.	0.4
Strongyloides ratti	74.0
Trichosomoides crassicauda	57.0
Acanthocephala:	
Moniliformis moniliformis	4.2

The incidence of the worms did not seem to depend upon the time of the year but rather, in the case of the flukes, at least, on the environment of their hosts. It was noticed at the termination of the survey that these particular parasites were obtained only from some of the rats that were trapped inside the piers of Manila Bay and in the immediate neighborhood of the landing places of boats along Pasig River. This may be regarded as purely accidental, but it may also mean that either the intermediate hosts of these flukes, which most probably are snails, exist in some of the bodies of water in Manila or the rats that harbored them might have been brought to the city from other localities on board of ships and boats. The matter deserves further inquiry.

DESCRIPTIONS OF PARASITES

The parasites determined represent two phyla in the animal kingdom, namely, the Platyhelminthes, or flatworms, and the Nemathelminthes, or roundworms. The flukes (class Trematoda) and the tapeworms (class Cestoda) are members of the phylum Platyhelminthes, while the so-called true roundworms (class Nematoda) and the proboscis worm (class Acanthocephala) belong to the Nemathelminthes.

Phylum PLATYHELMINTHES Claus, 1885

Class TREMATODA Rudolphi, 1808

Subclass DIGENEA v. Beneden, 1858

Order PROSOSTOMATA Odhner, 1905

Suborder DISTOMATA Zeder, 1800

Superfamily ECHINOSTOMATOIDEA Faust, 1929

Family ECHINOSTOMATIDÆ Looss, 1902

Subfamily ECHINOSTOMATINÆ Looss, 1899

Genus EUPARYPHIUM Dietz, 1909

EUPARYPHIUM ILOCANUM (Garrison, 1908) Tubangui, 1931. fig. 1.

Synonyms: *Fascioletta ilocana* Garrison, 1908; *Echinostoma ilocanum* (Garrison, 1908) Odhner, 1911.

For many years this fluke was regarded as a parasite peculiar to man in the northwestern provinces of Luzon, Philippine Islands. Its occurrence in rats has been only recently demonstrated by the present writer (Tubangui, 1931). In the survey

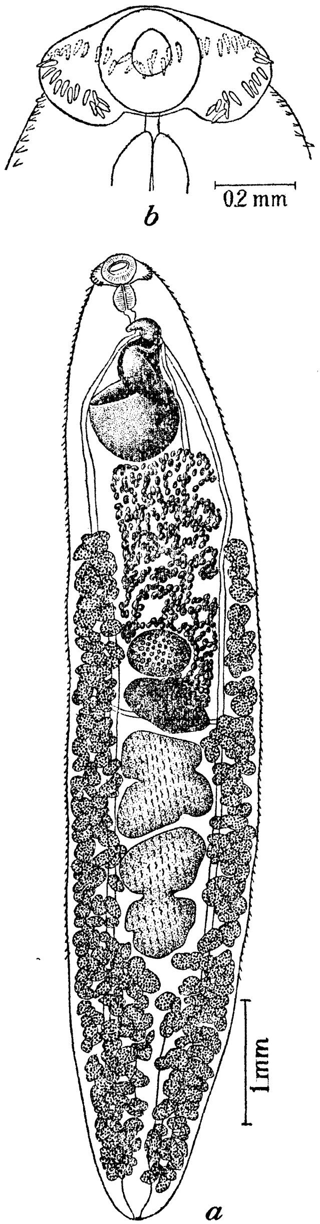

FIG. 1. *Euparyphium ilocanum*. *a*, Entire worm, ventral view; *b*, anterior end, showing arrangement of spines on cephalic collar, ventral view. (After Tubangui, 1931.)

on which this report is based, five or a little more than 0.5 per cent of the nine hundred fifty rats examined were infested with it.

Description.—Body moderately large, elongate, 5.57 to 8.02 millimeters in length by 1.33 to 1.58 millimeters in maximum breadth at or near the equator of body. Lateral sides of body from anterior end to acetabulum rolled ventrally. Cuticle armed with flat scalelike structures distributed ventrally from anterior end to second testis or slightly beyond that level, and dorsally from anterior end to anterior level of acetabulum; scales 13.5 to 24.7 by 13.5 to 18.0 microns in size, those at anterior end being smaller. Suckers close together; oral sucker small, subterminal, 0.19 to 0.24 millimeter in transverse diameter; acetabulum large, cup-shaped, at middle of anterior third of body length, 0.60 to 0.69 by 0.64 to 0.74 millimeter in size. Oral sucker surrounded dorsally and laterally by a collar (fig. 1, *b*) bearing fifty-one spines arranged in two alternating rows; collar 0.38 to 0.46 millimeter in diameter, reniform, its two rounded ventral angles united by a narrow ridge. Collar spines may be grouped as follows: Six ventral corner spines on each side of collar, the smallest of which measures 36.0 by 11.2 microns, the broadest 42.7 by 15.7 microns, and the longest 45.0 by 11.2 microns; fourteen lateral spines on each side, arranged in pairs and eleven dorsal spines; lateral and dorsal spines 31.5 to 45.0 by 11.2 to 13.5 microns in size.

Mouth terminal to subterminal, followed occasionally by prepharynx 0.03 to 0.05 millimeter in length; pharynx 0.19 to 0.20 by 0.15 to 0.17 millimeter in size; œsophagus 0.10 to 0.20 millimeter long, bifurcating immediately in front of genital pore, midway between pharynx and acetabulum or slightly anterior of that level; intestinal cæca reach posteriorly to from 0.24 to 0.43 millimeter from posterior end of body.

Testes tandem, postequatorial, at third fourth of body length, either elongate and each divided into anterior and posterior lobes by transverse constriction or shorter and distinctly 3- to 4-lobed. Cirrus sac large, 0.51 to 0.65 by 0.26 to 0.34 millimeter in size, reaching to but not extending posteriorly beyond equator of acetabulum; incloses prominent seminal vesicle, well-developed pars prostatica, and long protrusible cirrus. Common genital opening preacetabular, behind œsophageal bifurcation, to one side of median line.

Ovary globular or slightly compressed transversely, median, pretesticular, usually behind middle of second fourth of body length, 0.31 to 0.43 by 0.34 to 0.48 millimeter in size; shell gland between ovary and anterior testis; receptaculum seminis absent, Laurer's canal present; uterus well developed, occupying space bounded by ovary, acetabulum, and intestinal cæca. Vitellaria in moderately large follicles, commencing anteriorly on both sides at level about midway between posterior border of acetabulum and anterior border of ovary; anteriorly they are extracæcal, but behind second testis the follicles from the two sides unite and occupy most of posterior region of body; transverse vitelline ducts and vitelline reservoir dorsal of shell gland, directly in front of anterior testis. Eggs, numerous, operculated, light brown or yellowish, 85.5 to 101.5 by 54.0 to 65.2 microns in size.

Excretory system typical of echinostomes in general; excretory bladder long, with several small side branches, dividing into two principal branches behind second testis; excretory pore at extreme posterior end of body.

Location.—Small intestine.

Life history.—Unknown. It is most probable, however, from what is known of the life history of mammalian trematodes that the intermediate host is a fresh-water snail. It might be interesting to note moreover that the cercariæ of related flukes assume the infective stage by encysting within their own rediæ or in the tissues of their intermediate hosts; others encyst on plants, fishes, or in tadpoles.

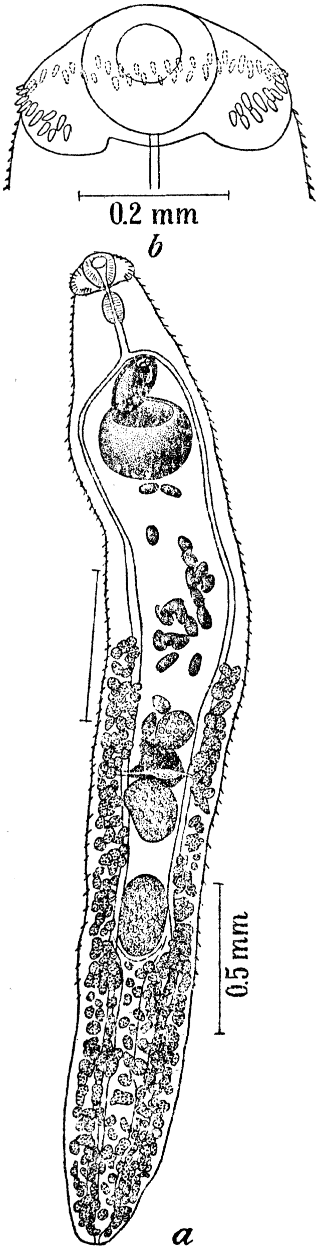

FIG. 2. ***Euparyphium guerreroi.*** ***a,*** **Entire worm, ventral view;** ***b,*** **anterior end, showing arrangement of spines on cephalic collar, ventral view. (After Tubangui, 1931.)**

Prevention.—Bearing in mind the possible modes of infestation with this parasite as noted in the discussion of its life history, prevention should consist in the avoidance of raw or improperly cooked vegetables, snails, and fishes and unboiled or unfiltered surface water as food and drink, respectively, especially in those places where the fluke is known to occur.

References.—14, 16, 21, 31, 41, 51, 55.[1]

EUPARYPHIUM GUERREROI Tubangui, 1931. Fig. 2.

Description.—Body slender, elongate, measuring 2.92 to 4.03 millimeters in length by 0.37 to 0.50 millimeter in maximum breadth across acetabulum or anywhere between this organ and anterior testis. Cuticle armed with flat scales, dorsally from anterior end to level of acetabulum and ventrally from anterior end to posterior testis or slightly beyond that level; scales 6.0 to 15.0 by 5.5 to 9.4 microns in size, anterior ones being smaller. Oral sucker small, subterminal, 0.10 to 0.12 millimeter in transverse diameter; acetabulum larger, at middle of anterior third of body length, 0.27 to 0.36 by 0.31 to 0.34 millimeter in size. Oral sucker surrounded dorsally and laterally by a collar (fig. 2, *b*) bearing fifty-five spines arranged in two alternating rows; collar 0.22 to 0.26 millimeter across, reniform, its two ventral angles united by a narrow ridge. Collar spines may be grouped

[1] The numbers refer to the list of references, which are arranged alphabetically and numbered, at the end of this paper.

as follows: Five ventral corner spines on each side of cephalic collar, 24.7 to 31.5 by 9.0 to 11.9 microns; fifteen lateral spines on each side, 27.0 to 29.2 by 9.0 microns; and fifteen dorsal spines, 11.2 to 13.5 by 6.7 to 9.0 microns in size.

Mouth subterminal to terminal, followed by prepharynx 0.03 to 0.07 millimeter long; pharynx 0.10 to 0.11 by 0.07 to 0.08 millimeter in size; œsophagus 0.08 to 0.15 millimeter long, bifurcating in front of level of genital pore; intestinal cæca long, narrow in diameter, reaching from 0.21 to 0.24 millimeter from posterior end of body.

Testes tandem, postequatorial, at third fourth of body length, oval or sausage-shaped, often transversely constricted into anterior and posterior lobes; anterior testis usually smaller, at least shorter, 0.19 to 0.36 by 0.15 to 0.22 millimeter in size; posterior testis 0.27 to 0.39 by 0.12 to 0.20 millimeter in size. Cirrus pouch oval, 0.17 to 0.27 by 0.10 to 0.13 millimeter in size, not reaching posteriorly beyond equator of acetabulum; incloses large seminal vesicle, moderately developed pars prostatica, and protrusible cirrus. Common genital opening preacetabular, behind œsophageal bifurcation, to one side of median line.

Ovary globular or slightly compressed, 0.10 to 0.15 by 0.07 to 0.13 millimeter in size, immediately preëquatorial, pretesticular; shell gland prominent, filling most of the space between ovary and anterior testis; receptaculum seminis absent, Laurer's canal present; uterus short, with few coils. Vitellaria in small to moderately large follicles, commencing anteriorly at middle of second fourth of body length, those on left side usually commencing at a more posterior level; behind second testis follicles from two sides unite and extend to posterior end of body; transverse vitelline ducts and vitelline reservoir dorsal of shell gland and immediately in front of first testis. Eggs few, operculated, thin shelled, light brown or yellowish, 78.7 to 85.5 by 54.0 to 60.7 microns in size.

Excretory system of usual echinostome type; excretory bladder long, tubular, dividing into two branches behind second testis; excretory pore at extreme posterior end of body.

Location.—Small intestine.

Life history.—Unknown.

Reference.—55.

EUPARYPHIUM MURINUM sp. nov. Fig. 3.

The description of this parasite is based on the examination of two lots of material. One lot, consisting of a small number of specimens, is part of our collection and was obtained from a

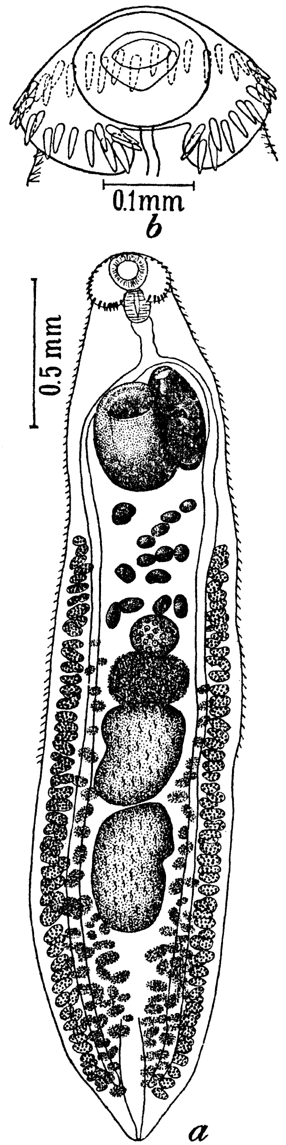

FIG. 3. *Euparyphium murinum* sp. nov. *a*, Entire worm, ventral view; *b*, anterior end, showing arrangement of spines on cephalic collar, ventral view.

rat that was at the same time infested with *E. ilocanum.* The other lot consisting of numerous specimens and labelled "parásitos encontrados en el intestino de un ratón, Manila, Agosto, 1909," was collected by Dr. Luis Guerrero. It was kindly turned over to me for determination by Dr. Onofre Garcia who found it among the parasitological collections of the University of Santo Tomas, Manila. I take this opportunity to express my thanks to Doctor Guerrero and Doctor Garcia.

This fluke differs from the two preceding species in the number of its collar spines, of which there are forty-five to forty-six, and in the position of its cirrus pouch that extends posteriorly beyond the equator of the acetabulum. In the number of its collar spines it is similar to *Echinostoma gotoi* Ando and Ozaki, 1923, another rat trematode, but again it may be distinguished from the latter by the position of its cirrus sac and also by the character of its uterus, which is short and contains only a few coils and eggs.

Description.—Body small, elongate, 2.65 to 4.50 by 0.45 to 0.65 millimeters in size. Cuticle armed with flat scales, dorsally from anterior end to acetabulum and ventrally from anterior end to posterior level of first testis or slightly beyond. Oral sucker small, subterminal, 0.10 millimeter in transverse diameter; acetabulum 0.32 to 0.42 by 0.23 to 0.32 millimeter in size, at anterior fourth of body length. Head collar reniform, 0.23 to 0.27 millimeter across, bearing forty-five spines arranged in two alternating rows and measuring 37.5 to 44.2 by

8.0 to 9.2 microns. Occasionally there are forty-six collar spines due to the presence of a small accessory dorsal spine (fig. 3, *b*).

Mouth subterminal; prepharynx absent or very short; pharynx oval, 0.10 to 0.13 by 0.07 to 0.09 millimeter in size; œsophagus 0.07 to 0.12 millimeter long, bifurcating immediately in front of level of genital pore; intestinal cæca long, reaching to near posterior end of body.

Testes tandem, postequatorial, oval to sausage-shaped, with smooth borders or slightly constricted at middle; anterior testis usually smaller, 0.32 to 0.48 by 0.16 to 0.25 millimeter in size; posterior testis 0.33 to 0.53 by 0.15 to 0.26 millimeter. Cirrus pouch oval, 0.25 to 0.36 by 0.10 to 0.13 millimeter in size, usually to one side of median line, dorsal to acetabulum and extending posteriorly beyond the equator of this organ; incloses seminal vesicle, pars prostatica, and protrusible cirrus. Common genital pore immediately preacetabular, a little to one side of median line.

Ovary globular or slightly transversely oval, preëquatorial, pretesticular, 0.10 to 0.15 millimeter in transverse diameter. Shell gland conspicuous, between ovary and first testis. Receptaculum seminis absent, the distal portion of oviduct being dilated and probably functioning as seminal receptacle; Laurer's canal present. Uterus short, with few coils. Vitelline glands in the form of distinct follicles extending from 0.10 to 0.60 millimeter behind acetabular level to near posterior end of body. Eggs few, oval, operculated, thin shelled, yellowish, 88.4 to 95.2 by 57.8 to 61.2 microns in size.

Excretory system of the usual echinostome type; excretory bladder tubular, bifurcating behind second testis; excretory pore at extreme posterior end of body.

Specific diagnosis.—Euparyphium: Body elongate, 2.65 to 4.50 by 0.45 to 0.65 millimeters in size. Head collar 0.23 to 0.27 millimeter in transverse diameter, with forty-five spines measuring 37.5 to 44.2 by 8.0 to 9.2 microns. Prepharynx very short or absent, œsophagus 0.07 to 0.12 millimeter long. Testes oval to sausage-shaped, with smooth borders or slightly constricted at middle; cirrus sac oval, 0.25 to 0.36 by 0.10 to 0.13 millimeter in size, reaching posteriorly beyond equator of acetabulum. Ovary globular or transversely oval, preëquatorial; vitellaria extend from 0.10 to 0.60 millimeter behind acetabular level to posterior end of body. Eggs few, 88.4 to 95.2 by 57.8 to 61.2 microns in size.

Location.—Small intestine.

Locality.—Manila, Philippine Islands.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 64; paratypes in parasitological collection of the University of Santo Tomas, Manila.

Life history.—Unknown.

References.—1, 10, 11, 13, 30, 31, 55.

Class CESTODA Rudolphi, 1808

Subclass CESTODA (s. str.) Monticelli, 1892

Order CYCLOPHYLLIDEA Braun, 1900

Superfamily TÆNIOIDEA Zwicke, 1841

Family TÆNIIDÆ Ludwig, 1886

Subfamily TÆNIINÆ Stiles, 1896

Genus TÆNIA Linnæus, 1758

TÆNIA TÆNIAFORMIS (Batsch, 1786) Wolffhügel, 1911. Fig. 4.

Synonym: *Tænia crassicollis* Rudolphi, 1810.

The larval stage of this tapeworm is commonly known as *Cysticercus fasciolaris* Rudolphi, 1808 (= *Strobilocercus fasciolaris* Sambon, 1924). It is one of the commonest parasites of the brown rat, the livers of 94 per cent of the animals examined being infested with it. The adult stage has so far been found only in cats. Krabbe, according to Stiles (1906), pointed out long ago that in Jütland sandwiches of chopped raw mice were eaten by the common people for the relief of anuria and suggested that this custom might be responsible for the occasional presence of the parasite in man. Thus far, however, no case of the sort has been reported.

Description.—The larvæ are inclosed in globular cysts, partly visible on the surface of the liver of infested rats as whitish semitransparent areas. These cysts are 5 to 16 millimeters in diameter and are easily separated from the hepatic tissue. The larvæ themselves are elongate, measuring 30 to 200 millimeters in length by 2 to 6 millimeters in maximum width near the anterior end. The body (fig. 4, *a*) is strobilate, which character differentiates it from the other bladderworms (*Cysticercus* species), for which reason Sambon (1924) proposed for it the term *Strobilocercus*. In living specimens the anterior portion is usually wider and thicker due to the contraction of

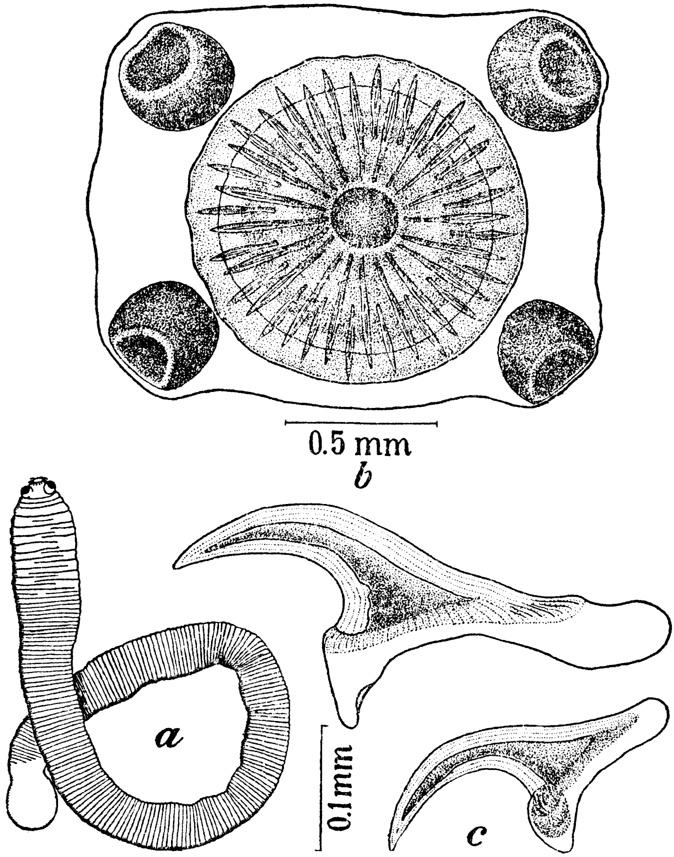

FIG. 4. *Tænia tæniaformis.* *a*, Entire larva (after Sambon, 1924); *b*, scolex, anterior view; *c*, rostellar hooks.

the body at this region and presents a terminal wedge-shaped depression due to the invagination of the scolex. The posterior end is usually more slender, terminating in a very much reduced bladder. Sometimes the segmentation of the body is so distinct and the length so great that this larvæ has been mistaken for a small mature tapeworm. Occasionally rudimentary reproductive organs are present among some of the segments. The scolex (fig. 4, *b*) is large, thick, 1.3 to 1.7 millimeters broad; suckers prominent, cup-shaped, 0.32 to 0.38 millimeter in diameter; rostellum short, columnar, 1.12 to 1.14 millimeter in diameter, crowned with 26 to 52 hooks, according to various authors (hooks of Philippine material 38 to 42). The hooks (fig. 4, *c*) are of the characteristic shape found in the group of tapeworms

to which this parasite belongs and are arranged in two concentric circles; those forming the upper row are larger, 380 to 420 microns long, their free pointed ends being almost on a line with those of the shorter hooks of the lower ring with which they alternate; the smaller hooks are 250 to 270 microns long.

Location.—Liver.

Life history.—The encysted strobilocercus in the liver of rats and other rodents represents the infective stage in the transmission of this parasite to its final host. If fed to a cat, the larva is liberated in the small intestine, attaches itself to the intestinal wall, increases in size, and, after two to three months, becomes mature. The eggs of the adult parasite escape with the fæces of the host and, if these are ingested by a rat or any other animal that can play the rôle of intermediate host, the inclosed embryos are freed from their shells in the intestine. These embryos on reaching the liver become encysted and are developed into strobilocerci. They reach the liver presumably through the circulatory system after penetrating through the intestinal wall.

References.—20, 27, 37, 49.

Family DAVAINEIDÆ Fuhrmann, 1907

Subfamily DAVAINEINÆ Braun, 1900

Genus RAILLIETINA Fuhrmann, 1920

RAILLIETINA GARRISONI sp. nov. Fig. 5.

Synonym: ? *Davainea madagascariensis* (Davaine) of Garrison, 1911.

This appears to be the commonest intestinal cestode infesting the brown rat in the Philippines. It bears a close resemblance to *R. celebensis*, but differs from the latter, as described by Janicki (1902) and by Meggitt and Subramanian (1927), in having a larger number of testes and uterine egg capsules and in the larger size of its cirrus pouch. It is, therefore, proposed as a new species and is named *Raillietina garrisoni* in honor of the late Dr. P. E. Garrison.

The parasite deserves more than passing notice due to its possible identity with *Davainea madagascariensis* (Davaine) of Garrison, 1911, which was collected at autopsy by Dr. Vernon L. Andrews from the small intestine of a male adult Filipino in Manila. According to Joyeux and Baer (1929) Garrison's material differs in the size of its rostellar hooks and of the cirrus pouch from the types described under the same name by other observers, and it is, therefore, likely that it represents another

species. According to the same authors it is allied to *R. celebensis* but differs from the latter in the size of its cirrus sac and in the number of its testes, which characters, it will be recalled, are the very ones that distinguish *R. garrisoni* from *R. celebensis.*

Joyeux and Baer are of the opinion that Garrison's *Davainea madagascariensis* and other rare human cestodes are parasites of wild animals that are accidentally transmitted to man. They suggest as one way of establishing the identity of these parasites the systematic collection and determination of the tapeworms of wild animals that habitually come in close contact with human beings in countries where such parasites have been recorded. The survey on which this report is based was, therefore, in line with the suggestion of the French authors and it is here shown that there exist important similarities in the morphology of *R. garrisoni* and of *D. madagascariensis* as described by Garrison (Table 2). In view of this and in view of the common occurrence of *R. garrisoni* in rats, a number of the parasites of which are transmissible to man, it is quite probable that Garrisons's tapeworm is identical with this species.

TABLE 2.—*Comparison between Raillietina garrisoni sp. nov. and Davainea madagascariensis (Davaine) of Garrison, 1911.*

	D. madagascariensis.	*R. garrisoni.*
Total length ... mm	390	Up to 600.
Size of terminal gravid segments ... do	2.0–2.5×1.0–1.5	1.60–2.12×1.05–1.40.
Diameter of head ... do	0.32–0.40	0.40–0.80.
Diameter of sucker ... do	0.105–0.125	0.10–0.15.
Number of rostellar hooks		90–140.
Length of rostellar hooks ... μ	23.5–25.2	20–26.
Number of testes	50	36–50.
Size of cirrus sac ... mm	0.12–0.16×0.064–0.100	0.13–0.18×0.054–0.085.
Position of genital pores	Normally unilateral; anterior.	Normally unilateral; anterior.
Diameter of uterine egg capsule ... mm	0.20–0.40	0.06–0.15 (measured from mounted specimens).
Number of eggs per egg capsule	1–3; generally 2	1–4; generally 3.
Size of eggs with elongated shell intact ... μ	50–64×19–23	52–80×22–26.
Length of embryonal hooks ... μ	4–5	4–6.

Description.—Total length up to 600 millimeters, the maximum breadth in the region of mature proglottids. Head (fig. 5, *b*) subglobular, 0.40 to 0.80 millimeter in diameter; suckers unarmed, 0.10 to 0.15 millimeter in diameter; rostellum 0.13 to

0.18 millimeter in diameter, armed with 90 to 140 hammer-shaped hooks (fig. 5, *a*) that are 20 to 26 microns in length and arranged in two alternating circular rows; rostellum with a spiny collar, the spines being comma-shaped and averaging about 5 microns long. Neck short, 0.28 to 0.36 millimeter in width. Segments broader than long except at posterior end where gravid proglottids may be nearly twice as long as wide (fig. 5, *d*); immature segments 0.08 to 0.17 millimeter long by 0.30 to 0.60 millimeter wide, mature segments 0.43 to 0.65 by 1.40 to 1.65 millimeters, and gravid segments 0.95 to 2.12 by 0.15 to 1.40 millimeters. Genital pores normally unilateral and dextral, situated near anterior extremity of lateral border of segments.

Main portion of excretory system represented by two pairs of lateral longitudinal vessels, ventral and dorsal; ventral pair more lateral in position, larger in diameter and connected in the posterior part of each segment by transverse canal; dorsal vessels small and with no transverse canals. Peripheral nervous system represented by a longitudinal nerve on each side, at middle between ventral excretory vessels and lateral margins of proglottids. Muscular system feebly developed and arranged as in other cestodes; consists of minute longitudinal and transverse fibers located immediately beneath cuticle and of longitudinal, transverse and dorsoventral fibers in parenchyma, of which the longitudinal and dorsoventral ones are most conspicuous.

Testes (fig. 5, *c*) small, roundish, 40 to 50 microns in diameter, confined within parenchyma between excretory vessels, 36 to 50 in number, of which 9 to 15 are on the poral side of the median line and 26 to 35 aporal. Vas deferens a long, much-convoluted tube near anterior border of segment, running almost transversely from median line to cirrus sac, passing with corresponding vagina between excretory vessels and ventral to longitudinal nerve. Cirrus sac distinctly gourd-shaped, 0.13 to 0.18 by 0.054 to 0.085 millimeter in size, extending either transversely or a little obliquely towards cephalic end from genital pore to longitudinal nerve.

Ovary (fig. 5, *c*) median, bilobed, each lobe being oval, with smooth surface and measuring 0.12 to 0.15 by 0.08 to 0.10 millimeter. Vagina a narrow canal, posterior to vas deferens and cirrus pouch, running transversely from median line to genital pore; before opening into genital pore it is usually slightly dilated to form a small receptaculum seminis. Near the median

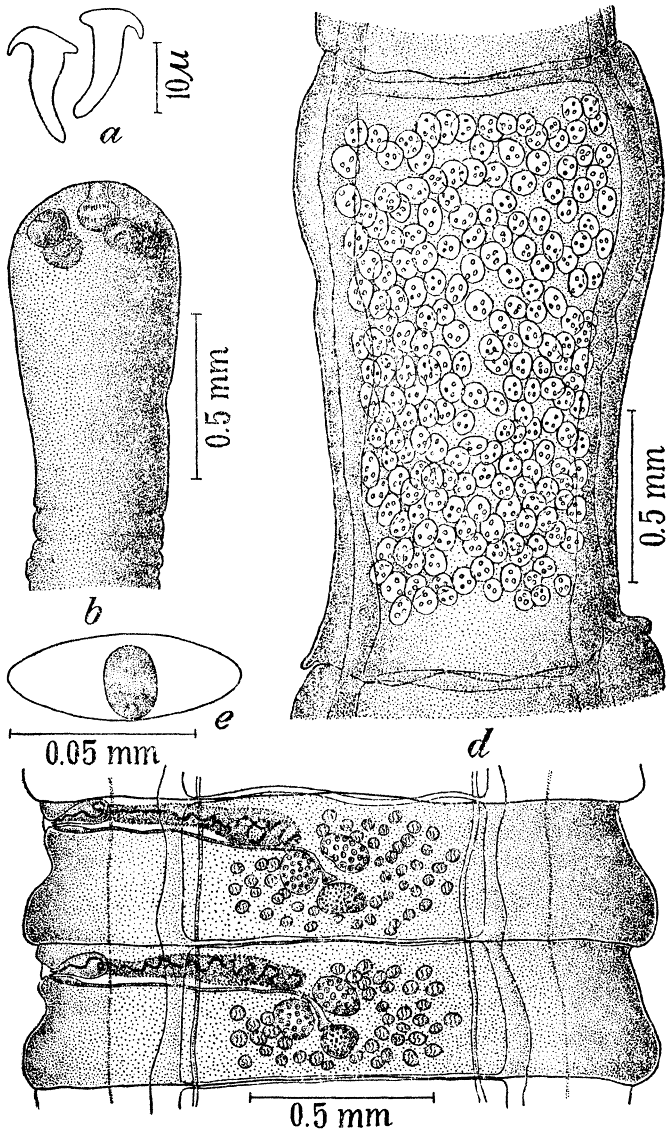

FIG. 5. *Raillietina garrisoni* sp. nov. *a*, Rostellar hooks; *b*, scolex; *c*, mature segment; *d*, gravid segment; *e*, egg.

line the vagina bends posteriorly and joins the oviduct, forming a slightly dilated tube, the oötype complex, between ovary and vitelline gland. Vitelline gland roundish to oval, immediately posterior to ovary, and measuring 0.09 to 0.13 millimeter across.

Uterus at first a simple sac filled with immature ova; in fully developed gravid segments it breaks down into numerous egg capsules, each containing 1 to 4, but mostly 3, eggs. Egg capsules (fig. 5, *d*) 0.06 to 0.15 millimeter in diameter, confined within excretory vessels, although a few of them may be found lateral to these canals, and numbering 180 to 200 in anterior gravid segments and 300 to 400 in elongated posterior gravid proglottids. Eggs (fig. 5, *c*) of characteristic shape, the onchosphere surrounded by two thin membranes: outer membrane elongated oval, 52 to 80 by 22 to 26 microns in size; inner membrane usually closely applied around onchosphere, round, 18 to 22 microns in diameter in fresh specimens; between inner and outer membranes a few connecting strands or fibers are sometimes present; onchosphere supplied with three pairs of embryonal hooks 4 to 6 microns long.

Specific diagnosis.—Raillietina: Length up to 600 millimeters, maximum breadth 1.4 millimeters. Head 0.40 to 0.80 millimeter in diameter; rostellum 0.13 to 0.18 millimeter in diameter, with 90 to 140 hooks 20 to 26 microns long; a spiny collar posterior to rostellum present, the spines being comma-shaped and about 5 microns long. Suckers unarmed, 0.10 to 0.15 millimeter in diameter. Genital pores normally unilateral and dextral, near anterior extremity of lateral border of segments. Cirrus sac 0.13 to 0.18 by 0.054 to 0.085 millimeter in size, extending only up to nerve. Testes 9 to 15 poral, 26 to 35 aporal, total 36 to 50. Egg capsules 180 to 400, each containing 1 to 4, generally 3, eggs; found mostly within excretory vessels, but a few lateral to them.

Location.—Small intestine.

Locality.—Manila, Philippine Islands.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 12.

Life history.—Unknown. Probably similar to the mode of development of most tapeworms, and in particular to other species of *Raillietina,* which utilize as intermediate hosts various forms of insects.

Prevention.—Due to reasons given above, this tapeworm may be looked upon with suspicion as one of those parasites of rats that are transmissible to man. Since the life history has not yet been worked out, however, no definite prophylactic measures can be given except to advocate the destruction of rats and mice, the proper disposal of the stools of infected persons, and the

practice of all-around cleanliness, by means of which all parasitic infestations can be avoided.

References.—17, 22, 25, 27.

Family HYMENOLEPIDIDÆ Railliet and Henry, 1909

Subfamily HYMENOLEPIDINÆ Ransom, 1909

Genus HYMENOLEPIS Weinland, 1858

HYMENOLEPIS DIMINUTA (Rudolphi, 1819) Blanchard, 1891. Fig. 6.

Synonyms: *Tænia diminuta* Rudolphi, 1819; *Hymenolepis flavopunctata* Weinland, 1858; *Tænia flavomaculata* Leuckart, 1863.

This common tapeworm of rats was first reported in man by Weinland in 1858. Since that time up to 1922, according to Riley and Shannon (1922), a total of sixty-one cases of human infestations with this parasite have been recorded from various parts of the world. To these should be added the one case detected by Schwartz and Tubangui (1922) in a native Filipino, the twenty Indian cases found by Chandler (1927), and the single case recently reported by Spindler (1929) from the United States.

Description.—Strobila composed of 800 to 1,300 proglottids; length 100 to 600 millimeters, depending upon number of proglottids; maximum width at posterior end in region of gravid segments, 2.5 to 4.0 millimeters. Head (fig. 6, *a*) almost globular, 0.20 to 0.60 millimeter broad; rostellum rudimentary, pyriform, without hooks; suckers globular, near apical portion of head, 0.08 to 0.16 millimeter in diameter. Neck short. Segments wider than long; immature segments 0.045 to 0.200 by 0.305 to 0.835 millimeter in size, mature segments 0.238 to 0.380 by 0.084 to 1.670 millimeters, and gravid segments 0.305 to 0.684 by 1.805 to 3.115 millimeters. Posterior border of segments only slightly wider than anterior borders, for which reason serration of strobila not as marked as in other cestodes. Genital pores usually unilateral and sinistral, at middle or at anterior third of lateral margins of proglottids. Main portion of excretory system consists of two pairs of lateral longitudinal vessels: a larger ventral pair connected in the posterior part of each segment by a transverse canal and a smaller dorsal pair with apparently no cross-connectives; the terminals of the ventral and dorsal vessels of one side are united in the region of the head. Muscular system fairly well developed, consisting of circular and longitudinal subcuticular fibers and another set of

longitudinal, transverse, and dorsoventral muscle fibers in the parenchyma.

Normally there are three testes in each mature segment—one poral and two aporal— arranged, more or less, in a straight line across segment and separated by ovary (fig. 6, *b*). Occasionally this arrangement is reversed; that is, there are two testes on the poral side of the ovary and one on the aporal side. Exceptionally, the two aporal testes are placed obliquely or one behind the other. In some segments, instead of the usual three testes, there may be only two, or there may be four to six. The testes are spherical, 0.12 to 0.14 millimeter in diameter. The vas deferens before entering the cirrus pouch is dilated to form a prominent seminal vesicle. Cirrus sac 0.17 to 0.30 by 0.02 to 0.04 millimeter in size in mature segment, 0.24 to 0.40 by 0.04 to 0.06 millimeter in gravid segments, extending from genital pore to or just past excretory vessels; incloses slender, protrusible cirrus.

Ovary bilobed, 0.35 to 0.40 millimeter across, median, intertesticular; surface indented to form small lobules. Vitelline gland lenticular in shape, immediately postovarial. Shell gland small, rounded, between ovary and vitelline gland. Receptaculum seminis large, prominent, extending transversely from median line to excretory vessels; it then becomes narrow in diameter and is continued as the vagina. The latter leads to the common genital pore, passing ventral and slightly posterior to the cirrus pouch. Uterus in pregravid segments in the form of a transversely elongated and apparently solid mass of cells representing young undeveloped ova; it soon becomes hollowed out, sending diverticula in all directions, and in the fully developed state it has the appearance of a sac incompletely divided by partitions into egg capsules and occupying nearly the entire space within a gravid segment (fig. 6, *c*). Mature eggs (fig. 6, *d*) spherical or slightly oval, the embryo proper or onchosphere being surrounded by three membranes, as follows: A thicker, very faintly radially striated outer membrane, 54 to 86 microns in diameter; a thinner envelope immediately surrounding embryo, oval in shape, 24 by 20 to 40 by 35 microns in size, often with two polar projections but without filaments as is the case with the eggs *Hymenolepis nana;* and an intermediate layer between outer and inner membranes, apparently composed of albuminous substance and often appearing as two delicate smooth membranes with intervening space filled by

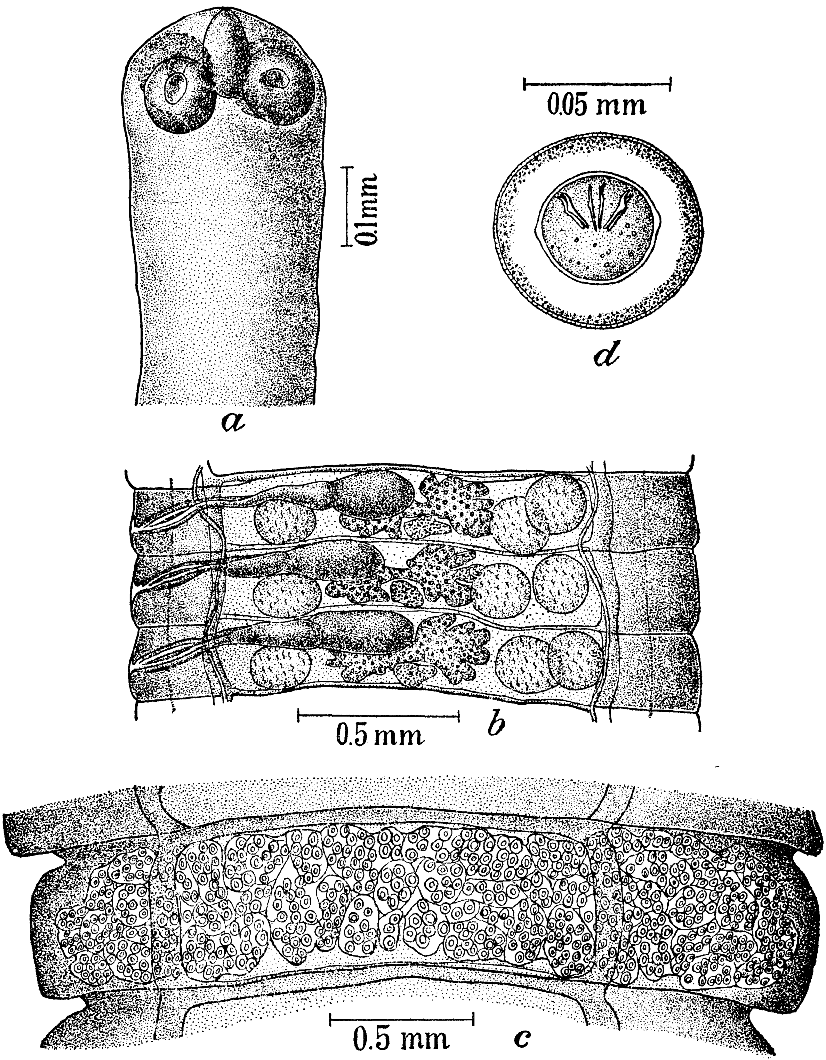

FIG. 6. *Hymenolepis diminuta.* *a*, Head; *b*, mature segment, dorsal view; *c*, gravid segment; *d*, egg.

granular substance. Embryonal hooks 10 to 16 microns in length.

Location.—Small intestine.

Life history.—Involves an intermediate host. If ingested by any of the following insects, the eggs will develop into infectious larvæ known as cysticercoids: Meal moth (*Anisopia farinalis*), earwig (*Anisolabis annulipes*), beetles (*Akis spinosa, Scaurus*

striatus and *Tenebrio molitor*), cockroaches (*Blatta orientalis* and *Phyllodromia germanica*), and rat fleas (*Ceratophyllus fasciatus* and *Xenopsylla cheopis*). The cysticercoids are found either free in, or encysted in the adipose tissue of, the abdominal cavities of the above insects. Rats as well as human beings become infected by ingesting these cysticercoids together with any of the above intermediate hosts.

Prevention.—Consists in the avoidance of rats and mice in houses, in the destruction of beetles, cockroaches, and other insects that act as intermediate hosts, in the protection of foods from such insects, and in the proper disposal of the stools of infected persons.

References.—8, 14, 25, 27, 33, 35, 40, 48, 49, 51.

HYMENOLEPIS NANA (Siebold, 1852) Blanchard, 1891. Figs. 7 and 8.

Synonyms: *Tænia murina* Dujardin, 1845; *Tænia ægyptiaca* Bilharz, 1852; *Hymenolepis fraterna* Stiles, 1906; *Hymenolepis longior* Baylis, 1922.

As indicated by its name (*nana,* or dwarf) one of the distinguishing characteristics of this cestode is its small size; hence it is commonly known as the dwarf tapeworm. It is a common parasite of rats and mice and of human beings in many parts of the world, especially in tropical and subtropical countries. Opinion, however, is divided on the identity of the dwarf tapeworm of rats and mice with the form found in man. Some consider the two forms as representing one and the same parasite (*vide* Woodland, 1924), while others believe that they are distinct (*vide* Joyeux, 1925). If the latter opinion should prove to be true, the rodent parasite would have to be designated as *Hymenolepis fraterna* Stiles, 1906, the older name, *Tænia murina* Dujardin, 1845, being preoccupied and, therefore, not available. The designation *nana* would then apply only to the human form. The present writer believes with Stiles (1906) that " from a standpoint of prevention they should at present be considered as identical," which opinion has been justified by the successful cross-infection experiments of Saeki (1920) and Woodland (1924) as well as by the recent epidemiological observations of Chandler (1927). The latter investigator concluded from his observations that rats are an important epidemiological factor in the dissemination of *H. nana,* for he found the distribution of the parasite in human beings in India to correspond very closely with that of another rat-borne disease; namely, bubonic plague.

The occurrence of this parasite in human beings in the Philippines has been recorded by Riley (1919), who found it in a

fæcal sample obtained from an American Bohemian child residing in Zamboanga, Mindanao, and forwarded to him by Dr. A. F. Coutant. The child was one of a family of five and it appears from the data furnished by the sender that the other members of the family were similarly infested with the worm in question. Among the files of the Bureau of Science for 1928 on the results of the routine examination of fæcal specimens submitted by the Philippine Health Service for evidences of intestinal parasitism, there is also an unpublished record of its presence in a young Chinese boy living in Manila. In Philippine rats, on the other hand, this is the first report of its occurrence, and it seems that it is rare in these animals, for it was found in only 1.7 per cent of the total number of rats examined.

Description.—Strobila composed of 96 to 840 proglottids; length 5 to 90 millimeters, depending upon number of segments; maximum width 0.20 to 0.90 millimeter, near posterior end. Head (fig. 8, *a*) subglobular, 0.13 to 0.48 millimeter in diameter; suckers globular, 0.07 to 0.15 millimeter in diameter; rostellum well developed, freely movable, armed near its anterior end with 20 to 30 characteristic hooks (fig. 7, *b*); latter 14 to 18 microns in length, with curved dorsal root directed anteriorly on rostellum and, directed posteriorly, a thick ventral root about equal in length to a sharp pointed prong with which it forms a sort of fork. Neck slender, 0.08 to 0.10 millimeter in length by 0.08 to 0.30 millimeter in width. Anterior segments very short; following segments increase in length and breadth but remain broader than long; most posterior segments, however, may be occasionally stretched and be as long as wide or even longer than wide. Measurements on Philippine material as follows: Immature segments 0.02 to 0.03 millimeter long by 0.14 to 0.17 millimeter wide, mature segments 0.04 to 0.08 by 0.17 to 0.32 millimeter, gravid segments 0.08 to 0.12 by 0.30 to 0.37 millime-

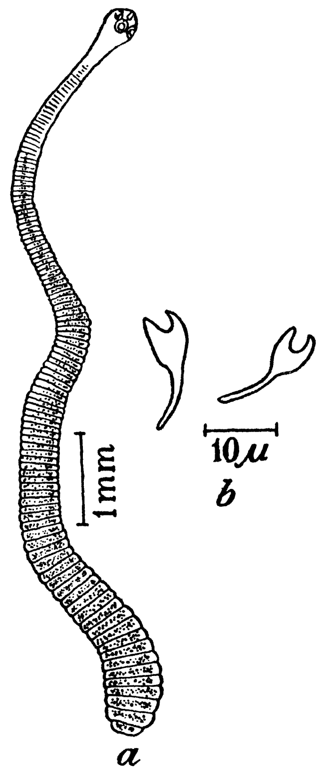

FIG. 7. *Hymenolepis nana.* *a*, Entire worm (from Ransom, 1904); *b*, rostellar hooks.

ter. Genital pores generally all on left side, near anterior border of segments.

Main portion of excretory system consists of two pairs of lateral longitudinal excretory vessels: a small dorsal pair and a larger ventral pair of vessels, the latter united in the posterior portion of each segment by a transverse canal; ventral and dorsal vessels of one side united in the region of the scolex and form an anastomosis at the base of the rostellum. Peripheral nervous system represented by a pair of longitudinal nerves, one on each side of strobila, lateral to excretory vessels. Muscular system weakly developed, consisting of outer circular and inner longitudinal subcuticular fibers and of longitudinal fibers in parenchyma; transverse and dorsoventral parenchymal fibers may also be present, but very few and weakly developed.

Three testes in each mature segment (fig. 8, *b*), normally one on left and two on right side of median line and usually arranged in more or less straight transverse line at posterior portion of proglottids; the arrangement, position, and number of these organs, however, are liable to variation as in *Hymenolepis diminuta;* they are globular, 28 to 34 microns in diameter. Vas deferens a slender canal for the most part; before entering cirrus pouch it may be dilated to form a small seminal reservoir; within cirrus pouch it may also be enlarged to form a seminal vesicle. Cirrus pouch club-shaped, 0.065 to 0.072 by 0.018 to 0.021 millimeter in size, its long axis directed transversely or sometimes obliquely forwards from genital pore to excretory vessels, passing dorsal to longitudinal nerve.

Ovary transversely elongated, bilobed, 0.10 to 0.12 millimeter across, lying ventral to testes. Vitelline gland rounded to oval in shape, immediately postovarial. Shell gland very small, between ovary and vitelline gland. Receptaculum seminis large, prominent, extending transversely from median line to excretory vessels; it then becomes narrow in diameter and is continued as the vagina. Latter leads to common genital pore, passing between cirrus pouch and excretory vessels and nerve. Uterus at first a transversely elongated cellular mass in front of ovary; it soon hollows out and assumes in the oldest segments the form of a sac containing many infoldings or incomplete partitions (fig. 8, *c*) ; it is more or less completely filled with eggs numbering 80 to 180 in each gravid segment. Eggs (fig. 8, *d*) oval or globular, with two distinct membranes separated by an intervening space containing a finely granular transparent sub-

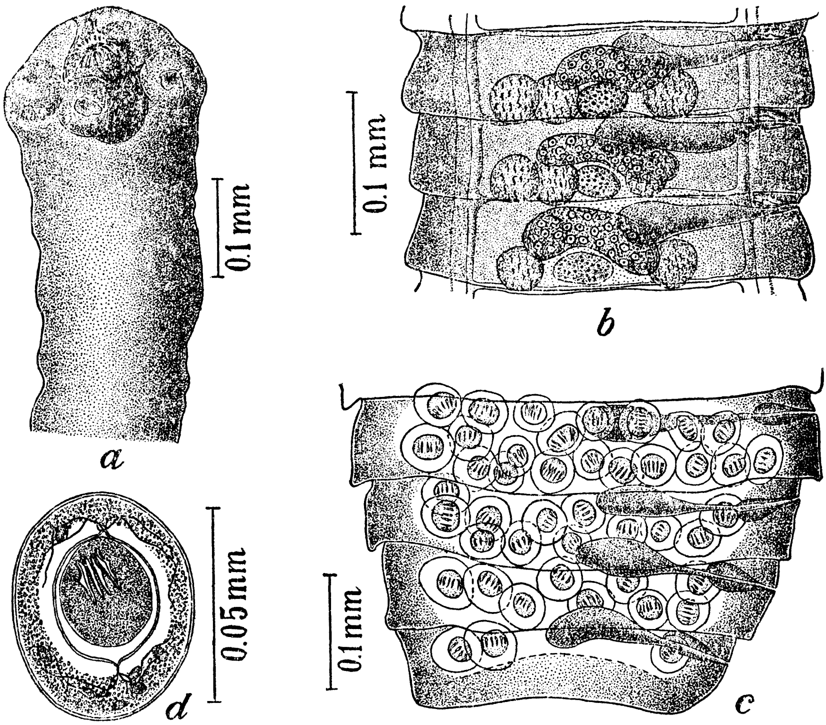

FIG. 8. *Hymenolepis nana.* *a*, Head; *b*, mature segment, ventral view; *c*, gravid segment; *d*, egg.

stance; outer egg membrane, according to various authors, 30 to 60 microns in diameter; inner membrane 16 to 34 microns in diameter, usually with more or less conspicuous mammillate projection at each pole and filamentous appendages; embryonal hooks 10 to 14 microns long. (Measurements of eggs of Philippine material as follow: Outer membrane 45 to 60 by 34 to 51 microns, inner membrane 30 to 34 by 23.5 to 27.2 microns.)

Location.—Small intestine.

Life history.—This parasite is unique among the other cestodes in that it has a one-host life-cycle; that is, it is capable of completing its development from egg to adult in a single individual host. This peculiar life history was first demonstrated by Grassi (1887) and has subsequently been confirmed by the more recent studies of Joyeux (1920), Woodland (1924), and others.

The mature eggs (onchospheres) are discharged with the fæces of an infested animal. If swallowed by a proper host

(for example, a rat), the inclosed embryos become free in the intestinal tract and develop into cysticercoids within the intestinal villi. The cysticercoids then reënter the alimentary canal where they grow into adult tapeworms.

Prevention.—Avoid rats and mice in houses; keep foods out of the reach of rats and mice, especially foods that are eaten raw, or after cooking are kept for some time before being eaten; avoid introducing into the mouth dirty and unnecessary objects that are apt to be contaminated with the eggs of the parasite. Infested persons should observe strict personal cleanliness, especially after defecation and their stools should be properly disposed of.

References.—8, 14, 18, 23, 24, 25, 27, 33, 36, 48, 49, 51, 58, 59.

Phylum NEMATHELMINTHES Vogt (quoted by Carus, 1863)

Class NEMATODA Rudolphi, emend. Diesing, 1861

Order EUNEMATODA Ward, 1916

Superfamily RHABDIASOIDEA Railliet, 1916

Family RHABDIASIDÆ Railliet, 1915

Genus STRONGYLOIDES Grassi, 1879

STRONGYLOIDES RATTI Sandground, 1925, fig. 9.

Synonym: *Strongyloides papillosus* (Wedl, 1856) Hall, 1916.

This minute worm was found in scrapings from the mucous membrane of the small intestine of 74 per cent of the rats examined. In a large number of the cases it was associated with *Nippostrongylus muris*. As indicated by Sandground (1925), it may be distinguished from *S. papillosus* (Wedl, 1856) of sheep, goats, and rabbits, with which it has been confused, by its smaller size, the finer striations of its cuticula, and the course of its ovaries.

Description.—Parasitic generation, represented by females, 2.20 to 2.75 millimeters long by 30 to 35 microns thick. Body filiform, attenuated anteriorly; posterior end behind anus suddenly tapers into a short pointed tail. Cuticle finely striate. Mouth surrounded by three minute papillæ; leads directly to œsophagus. Œsophagus 0.70 to 0.78 millimeter long, gradually increasing in diameter posteriorly. Excretory pore 0.10 to 0.12

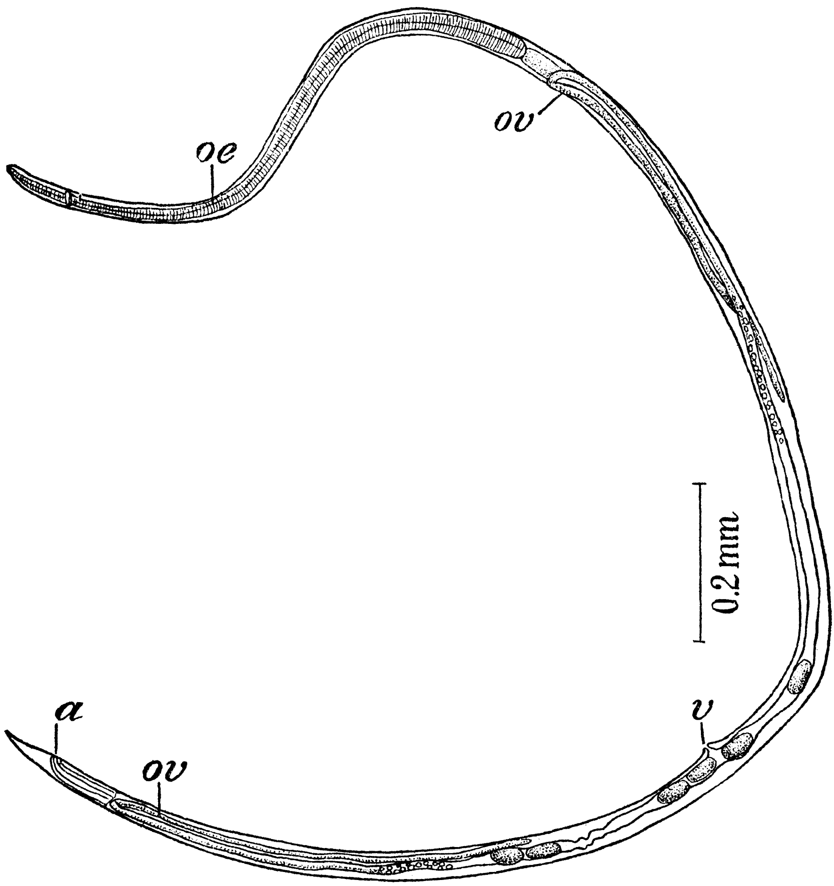

FIG. 9. *Strongyloides ratti,* entire worm. *a,* Anus; *oe,* œsophagus; *ov,* ovary; *v,* vulva.

millimeter from anterior end. Nerve ring immediately in front of excretory pore. Anus 42 to 45 microns from posterior end. Vulva with prominent lips, 1.70 to 1.82 millimeters from anterior end. Ovaries directly recurrent, their bends being close to œsophageal and anal ends of digestive tract; each is continued as oviduct, then as uterus, so that uteri are divergent. Eggs few in number (maximum 10 or 11 in both uteri), 51 to 56 by 27 to 29 microns in size (according to Sandground, 47 to 52 by 28 to 31 microns); they contain larvæ at deposition.

Location.—Small intestine.

Life history.—As shown by Sandground (1926), the life history is very similar to that of *Strongyloides stercoralis* of man. The eggs hatch while still in the small intestine of the host

and the liberated, actively motile, rhabditiform embryos are passed with the fæces. These may either develop immediately into filariform larvæ that are capable of infesting new hosts or become mature free-living males and females that copulate and produce eggs, from which free-living rhabditiform larvæ are hatched. The latter are then transformed into infective filariform larvæ. Infestation is usually through the skin, the filariform larvæ being capable of boring through the integument of the host.

References.—7, 19, 38, 63.

Superfamily TRICHUROIDEA Railliet, 1916

Family TRICHOSOMOIDIDÆ Yorke and Maplestone, 1926

Subfamily TRICHOSOMOIDINÆ Hall, 1916

Genus TRICHOSOMOIDES Railliet, 1895

TRICHOSOMOIDES CRASSICAUDA (Bellingham, 1840) Railliet, 1895. Fig. 10.

Synonyms: *Trichosoma crassicauda* Bellingham, 1840; *Trichosoma muris decumani* Rayer, 1843.

Description.—Marked sexual dimorphism: male much smaller than, and usually parasitic in vagina or uterus of, female (fig. 10, *a*). Anus posteroterminal in both sexes.

Male 1.60 to 5.20 millimeters in length by 19 to 40 microns in maximum width, according to various authors. Body threadlike, not distinctly divided into slender anterior and enlarged posterior portions. Cuticle very finely striated transversely. Anterior end (fig. 10, *b*) with terminal stylet and prepucelike cuticular sheath, according to Thomas (1924). Œsophagus 0.70 to 1.28 millimeters long or about one-half to one-third of total body length. Testis single, tubular, originating from anterior region of body and extending to near posterior end, where it is transformed into a small seminal vesicle. Spicule, bursa, or copulatory organs of any sort absent.

Female 10.5 to 14.6 millimeters in length by 0.175 to 0.200 millimeter in maximum thickness near posterior end. Body covered with transverse cuticular ridges except at extreme anterior end; it is divided into a slender anterior portion, corresponding to length of œsophagus, and into a thicker posterior portion occupied by intestine and reproductive organs. Head rounded, 20

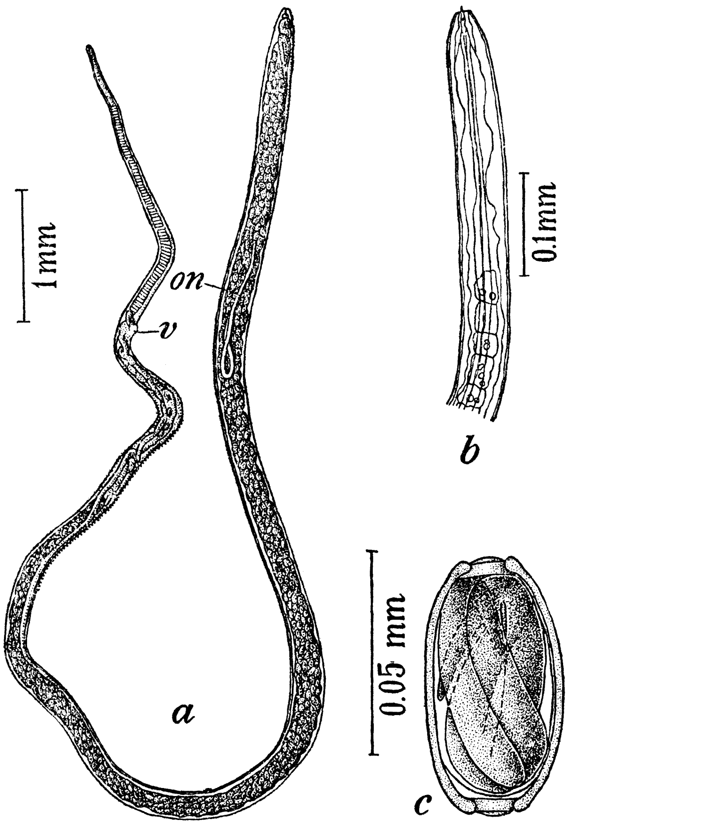

FIG. 10. *Trichosomoides crassicauda.* *a,* Mature female with male in uterus (after Hall, 1916), *m,* male worm; *v,* vulva; *b,* anterior end of mature male (after Thomas, 1924); *c,* egg.

to 22 microns in diameter. Mouth simple, minute. Œsophagus a capillary tube, 1.50 to 1.90 millimeters long, which is equal to between one-sixth and one-eighth of total body length; most of the anterior portion of œsophagus apparently free of surrounding cells, the rest passing through a chain of large œsophageal cells. Vulva ventral, immediately behind œsophageal termination. Vagina long, thin-walled, directed posteriorly, distinguised from uterus by presence of dark brown eggs. Uterus reaches to near posterior end of body. Eggs (fig. 10, *c*) generally oval but may be subspherical or cylindrical, thickshelled, plugged at both poles, embryonated at deposition, 61.2 to 72.0 by 25.0 to

56.0 microns in size. They are colorless in the uterus, but in the vagina they become dark brown.

Location.—Urinary bladder; also renal pelvis and ureters.

Life history.—Simple and direct. If ingested by the proper host, the eggs, which contain well-developed embryos when oviposited and which are passed out with the urine of an infected animal, hatch in the stomach of the host. The newly-hatched larvæ measure 264 to 390 microns in length by 10 to 16 microns in maximum width and are provided with a terminal stylet and a prepucelike fold at the anterior end. After boring out through the wall of the digestive tract these larvæ enter the blood stream and are carried to the heart by way of the portal system. According to Yokogawa (1921), they have to pass through the lungs before they can establish themselves in their normal habitat. The experiments of Thomas (1924), however, do not indicate that passage through the lungs is absolutely essential in the development of this parasite in the same sense that *Ascaris* larvæ, for example, must go through these organs before they can become adults. According to Thomas, the larvæ of *Trichosomoides crassicauda* are dispersed by the circulatory system to different parts of the body, but only those that become lodged in the urinary tract are able to complete their development. The adult state is reached in three to six weeks after the ingestion of the eggs. Copulation takes place at any point in the urinary tract. The male enters the vagina of the female and may either remain there permanently or wander out again.

References.—19, 52, 61, 63.

Family TRICHURIDÆ Railliet, 1915

Subfamily CAPILLARIINÆ Railliet, 1915

Genus HEPATICOLA Hall, 1916

HEPATICOLA HEPATICA (Bancroft, 1893) Hall, 1916. Fig. 11.

This appears to be one of the commonest parasites of the brown rat in the Philippines, about 90 per cent of the rat livers examined showing the presence of irregular white or yellowish spots that mark the presence of the worm's eggs. It is at the same time one of those helminths that are able to establish themselves in a variety of hosts other than rats and mice. It has been reported from the European hare (*Lepus europus*), the rabbit, and the prairie dog (*Cynomys ludovicianus*). The guinea pig, dog, and monkey are also susceptible to

it. In man the first and, up to the present time, the only report of its occurrence is that by Dive and Lafrenais (1924), who recovered the parasite from a British soldier who lived for three years in India. At autopsy the subject presented a liver abscess, in the proximity of which were masses of the parasite's eggs; the worms themselves were found in the periphery of the abscess.

Description.—Body capillary divided into anterior œsophageal and posterior portions. Cuticle delicately striate, apparently without bacillary band. Mouth simple. Worms, both male and female, 40 to 50 millimeters long.

Male 28 microns thick at posterior end; anterior and posterior portions of body about equal in length. Spicule absent, but represented by membranous sheath prolonged from posterior extremity.

Female 100 to 120 microns thick at middle of body and 65 microns at tail. Anterior portion of body about half as long as posterior portion. Vulva (fig. 11, *a*) prominent, 6 to 7 millimeters from anterior end, opening at level of posterior œsophageal region. Tail very short, blunt and conical. Oviparous; eggs lemon-shaped, double walled, 54 to 58 by 32 to 34 microns in size, plugged at each pole (fig. 11, *b*); outer eggshell striate, inner shell homogeneous.

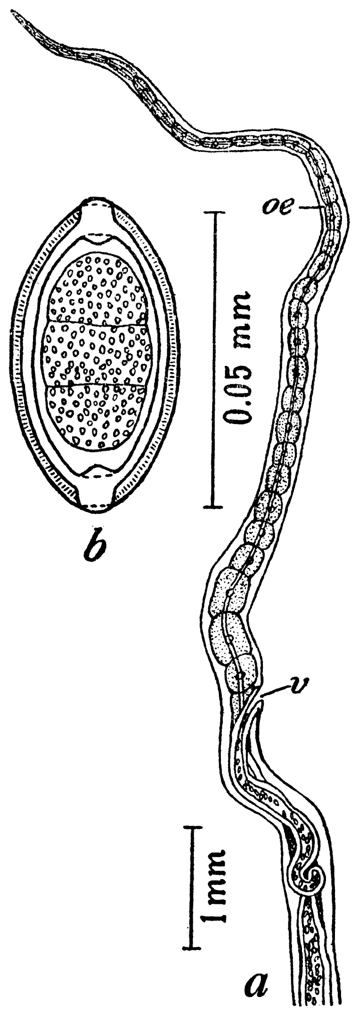

FIG. 11. *Hepaticola hepatica*. *a*, Anterior end of mature female (after Nishigori, from Yorke and Maplestone, 1926); *oe*, œsophagus; *v*, vulva; *b*, egg.

Location.—Liver.

Life history.—The life history is simple and direct; that is, it does not involve any intermediate host. The eggs, as encountered in the liver of recently dead rats, are nonsegmented or in the very early stage of segmentation, and are not infectious.

Their development to the infectious embryonated stage is quite slow, taking about five to six months according to Bancroft and to Railliet, and only twenty-three days according to Momma (1930). If mature eggs are ingested by a proper host, hatching takes place in the small intestine and the newly liberated larvæ, after penetrating through the intestinal wall, reach the liver by way of the circulatory system, according to Fülleborn (1924). According to Nishigori (1925) and Asada (1925), they pass through the intestinal wall into the abdominal cavity, from which they make their way into the liver through the surface of this organ. In any case, the larvæ, after reaching the liver, stay there to complete their development. Larvæ may sometimes be carried to the lungs and other organs, in which case they do not become mature and sooner or later die.

In connection with this mode of development it is not yet clear how the eggs are discharged from the body and how they are transmitted from one host to another. According to Railliet (1892) and others who state that they have seen the eggs in the fæces, it is presumed that they escape through the intestinal tract from the liver through the bile duct. On the other hand, according to Bancroft (1893), Weidman (1925), and others who have failed to detect their presence in the fæces of infested animals, the belief is that the transmission of the eggs probably depends upon the cannibalistic habit of the host animals. This, however, could hardly be considered in the case of the human infestation recorded above. Even with rats direct infestation through cannibalism is possible only if a rat will devour another rat (infested) that has been dead for several months and in which the eggs have had time to develop into the infective stage. Indirectly, however, cannibalism may play a distinct rôle in the spread and propagation of the parasite if it could be shown that the immature eggs, as found in the liver, will still continue their development after passing through the digestive tract of a rat. In this connection the recent observations of Momma (1930) and Shorb (1931) are interesting. These authors cultured eggs derived from the fæces of flies and cats that had been fed on infested rat livers and found that they developed normally to the infective stage. It may, therefore, be deduced that the eggs of *Hepaticola hepatica* are disseminated through the natural decomposition and disintegration of the dead bodies of infested animals and through the capture and ingestion of infested rats and mice by their own

kind, or by cats, and other rat-preying animals. According to Momma, flies may play a rôle in the dispersal of the ova since they are often seen in large numbers around the decomposing bodies of dead rats.

Prevention.—Avoid rats and mice in houses; the dead bodies of these animals should not be allowed to decompose in the open, but should be buried deeply in the ground or burned; protect foods from rodents and from flies.

References.— 2, 3, 12, 14, 15, 19, 28, 29, 32, 45, 51, 57, 63.

Superfamily STRONGYLOIDEA Weinland, 1858; Hall, 1916

Family TRICHOSTRONGYLIDÆ Leiper, 1912

Subfamily HELIGMOSOMINÆ Travassos, 1914

Genus NIPPOSTRONGYLUS Lane, 1923

NIPPOSTRONGYLUS MURIS (Yokogawa, 1920) Lane, 1923. Fig. 12.

Synonym: *Heligmosomum muris* Yokogawa, 1920.

Description.—Body small, filiform, coiled, blood red in color when fresh. Cervical alæ absent, but cuticle inflated in head region (fig. 12, *a*); length of cuticular expansion 0.058 to 0.063 millimeter. Cuticle with ten longitudinal ridges originating behind inflated area; transverse striation of cuticle evident on these ridges. Mouth simple, leading into small buccal cavity. Œsophagus 0.30 to 0.40 millimeter long. Nerve ring 0.20 to 0.23 millimeter from anterior end. Excretory pore a short distance in front of nerve ring. Cervical papillæ lacking.

Male 3.2 to 3.5 millimeters long by 0.08 millimeter in maximum thickness at middle of body. Bursa well developed, with conspicuous asymmetrical lateral lobes and rays and small dorsal lobe (fig. 12, *b*). Right lobe larger, at least longer, than left lobe, its supporting rays differing from those of opposite side: ventroventral ray small, slender, widely separated from lateroventral which is also thin but longer; externolateral and mediolateral thick and close together except at their tips; posterolateral small and delicate; externodorsal on both sides thin and slender, arising at slightly higher level from common trunk with dorsal ray. In the left lateral bursal lobe, the ventroventral, lateroventral, externolateral and mediolateral rays are almost similar in form, being long and thin; posterolateral thicker and curved dorsally, ending in a conical tip. Dorsal ray bifurcate at its tip, each limb ending in two or three digitations. Spicules yellowish in color, equal, filiform, 0.44 to

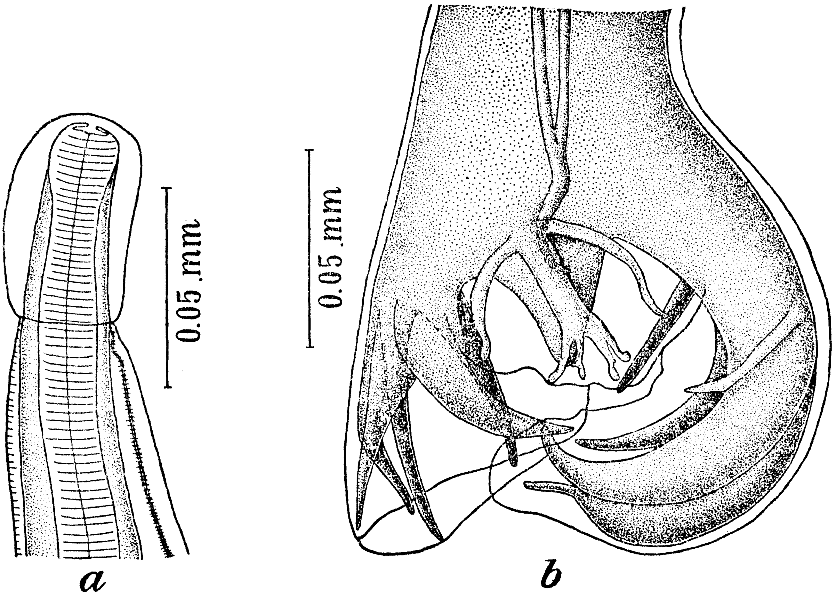

FIG. 12. *Nippostrongylus muris.* *a,* Anterior end, lateral view; *b,* bursa, dorsal view.

0.50 millimeter in length by 6 to 7 microns in maximum width at their proximal ends, with sickle-shaped extremities that are usually united together. Gubernaculum colorless, 44 to 46 microns long.

Female 4.0 to 4.6 millimeters in length by 0.135 millimeter in maximum thickness at middle of body. Posterior end behind vulva reduced abruptly in diameter ending in a short, curved, conical tail; in contracted specimens this region of the body may appear swollen and bell-shaped due to the invagination of the cuticle which carries with it the anus and the vulva. Anus about 32 microns from tip of tail. Vulva in front of anus, about 80 microns from tip of tail; vagina muscular, separated from uterus by ovejector; uterus short, modified anteriorly into receptaculum seminis; ovary long, with short anterior loop. Eggs few in number, thin shelled, segmented at deposition, 58 to 60 by 30 to 32 microns in size.

Location.—Small intestine.

Life history.—The life history of this nematode has been worked out by Yokogawa (1922). When passed out in the fæces of the host, the eggs are in various stages of segmentation. Under favorable conditions their development is continued outside and hatching takes place after about twenty to twenty-four hours.

The newly hatched larvæ attain the infective stage after about five days. The infection of new hosts is accomplished, as in the case of hookworms, by the larvæ entering the body either through the skin or by way of the mouth, the former method having been shown to be more effective. After passing through the lungs the larvæ settle down in the intestine where they reach sexual maturity in seven to ten days after infestation.

References.—26, 60, 62, 63.

Superfamily OXYUROIDEA Railliet, 1916

Family OXYURIDÆ Cobbold, 1864

Subfamily SYPHACIINÆ Railliet, 1916

Genus SYPHACIA Seurat, 1916

SYPHACIA OBVELATA (Rudolphi, 1802) Seurat, 1916. Fig. 13.

This parasite is listed by Shipley (1908) and by Stiles and Hassall (1910) among the nematodes reported from *Mus norvegicus*. As already stated, it was not encountered in the present survey, but attention is called to it in view of its recorded occurrence in the Philippine Islands by Riley (1919) who identified it from specimens found in a sample of human stools obtained from an American Bohemian child residing in Zamboanga, Mindanao, and forwarded to him by Dr. Albert F. Coutant. The following description is mostly adopted from Hall (1916).

Description.—Body elongate, fusiform. Cuticle transversely striate, not dilated in head region. Two small cervical alæ present (fig. 13, *a*). Mouth bounded by three lips, each bearing a median papilla on its outer face; mouth cavity simple. Œsophagus club-shaped with a posterior bulb containing a valvular apparatus and separated from the rest by a constriction. Excretory pore a little posterior of level of œsophageal bulb.

Male (fig. 13, *b*) 1.3 millimeters long by 115 microns thick, with two or three cuticular "mamelons" on ventral surface. Posterior extremity coiled in a spiral and ending in a long pointed tail. Narrow caudal alæ present, limited to first part of tail, supported by two pairs of preanal and one pair of postanal pedunculated papillæ (fig. 13, *c*). Spicule simple, slightly curved, 85 microns long by 7 microns thick at base; gubernaculum shaped like a ploughshare, 37 microns long, directed transversely posterior of spicule. Cloacal aperture 210 microns from tip of tail; posterior lip of aperture with a small chitinous hook that may be of use in copulation.

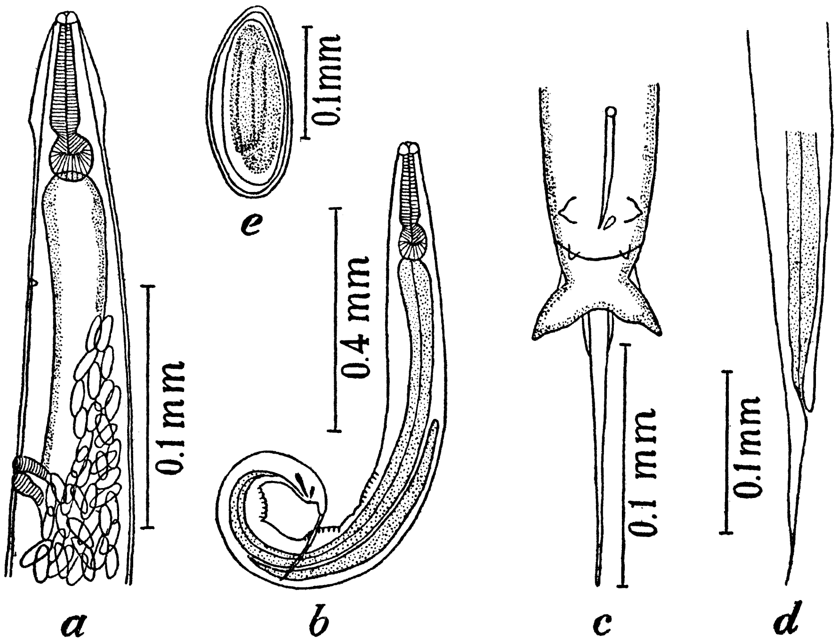

FIG. 13. *Syphacia obvelata*. *a*, Anterior end of female, lateral view; *b*, male, lateral view; *c*, posterior end of male, ventral view; *d*, posterior end of female, lateral view; *e*, egg. (All from Yorke and Maplestone, 1926.)

Female 3.5 to 5.7 millimeters long by 115 to 215 microns thick. Body terminates in a long, narrow tip posteriorly (fig. 13, *d*.) Œsophagus, exclusive of bulb, 255 to 330 microns long by 50 to 70 microns thick; œsophageal bulb 85 to 100 by 75 to 110 microns in size. Nerve ring 100 to 130 microns from anterior end. Anus 515 to 705 microns from tip of tail. Vulva prominent, behind excretory pore, situated on conical cuticular prominence 540 to 740 microns posterior of head. Vagina extends posteriorly from vulva, elongate, about 170 microns long. Uterine branches do not extend posterior of anus. Eggs 110 to 142 by 30 to 40 microns in size, nonembryonated at time of oviposition (fig. 13, *e*).

Location.—Cæcum and large intestine.

Life history.—Unknown. Probably similar to that of closely related nematodes, such as, *Enterobius vermicularis*, the human pin worm, the life history of which is simple and direct.

Prevention.—Taking for granted that the life history of this parasite is simple and direct, the preventive measures that suggest themselves are the observance of personal cleanliness, es-

pecially after defecation, the proper disposal of the stools of infected individuals, the destruction of rats and mice, and the protection of foods from the droppings of these animals.

References.—14, 19, 34, 42, 44, 50, 51, 63.

Family HETERAKIDÆ Railliet and Henry, 1914

Subfamily HETERAKINÆ Railliet and Henry, 1912

Genus HETERAKIS Dujardin, 1845

HETERAKIS SPUMOSA Schneider, 1866. Fig. 14.

Synonym: *Ganguleterakis gangula* Lane, 1914.

Description.—Body small, tapering slightly towards the anterior end. Cuticle with fine longitudinal and transverse striations and with lateral flanges in œsophageal region (fig. 14, *a*). Head 70 to 75 microns in diameter. Mouth with three subequal lips, each lip carrying two lateral papillæ. Œsophagus 0.75 to 0.83 millimeter long, subcylindrical, terminating in a well-developed bulb; latter 0.15 to 0.17 millimeter in diameter, provided with a valvular apparatus. Distance from anterior end to nerve ring 0.22 to 0.24 millimeter; to excretory pore 0.29 to 0.31 millimeter; to cervical papillæ 0.30 to 0.34 millimeter.

Male 6.0 to 7.4 millimeters in length by 0.25 millimeter in maximum thickness. Tail short and sharply pointed. Caudal alæ well developed, provided with ten pairs of papillæ grouped as follows (fig. 14, *c*): an anterior group of two pairs of ventral papillæ lateral to genital sucker, a middle group of two pairs of ventral and three pairs of lateral papillæ in the cloacal region, and a posterior group of three pairs of lateral papillæ near tip of tail. The anterior group of papillæ are all slender; in the middle group the ventral pairs are short and knobby, while the lateral pairs vary in size and appearance, the first pair being the largest, the second pair thick but short, and the last pair longer but slender; the posterior group of papillæ are relatively small, the middle pair being the largest among them. Genital sucker slightly oval transversely, pedunculate, with a strong chitinous rim interrupted posteriorly by a papilliform projection; average size 0.076 by 0.087 millimeter and about 0.15 millimeter from cloacal opening. Spicules subequal, tapering distally, 0.280 to 0.315 millimeter in length. Gubernaculum absent. Cloacal opening 0.29 to 0.32 millimeter from tip of tail.

Female 7.8 to 9.5 millimeters in length by 0.30 to 0.32 millimeter in maximum thickness. Tail long and acutely pointed (fig. 14, *b*). Anus 0.58 to 0.64 millimeter from tip of tail.

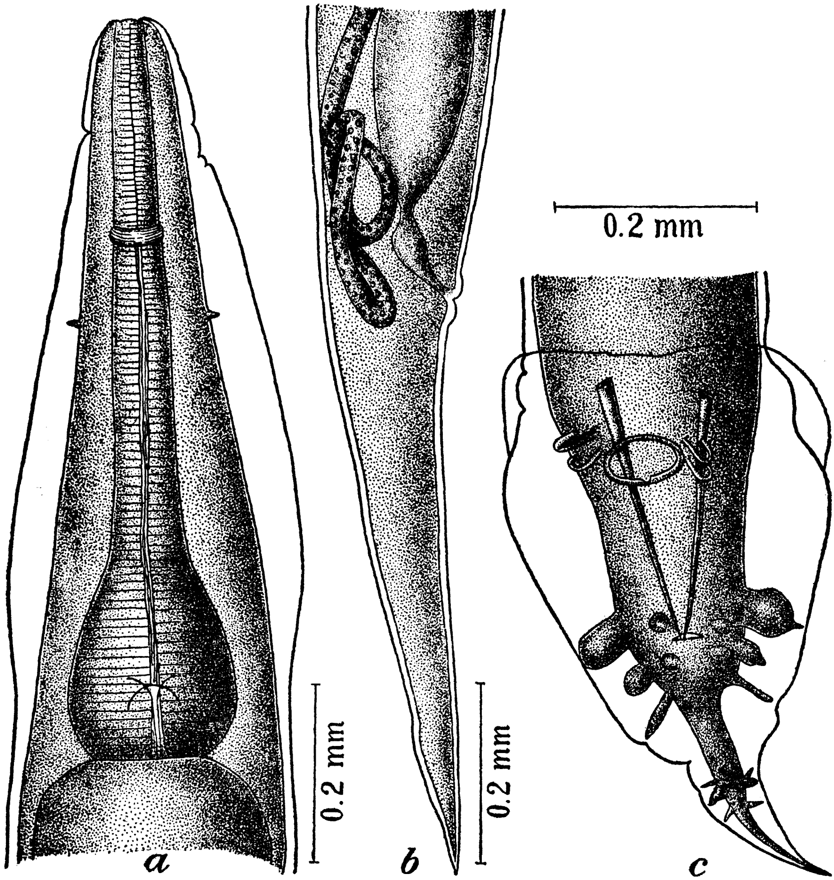

FIG. 14. *Heterakis spumosa.* *a*, Anterior end of female, ventral view; *b*, posterior end of female, lateral view; *c*, posterior end of male, ventral view.

Vulva slightly posterior of middle of body length. Vagina muscular, is at first directed anteriorly, then bends posteriorly and divides into anterior and posterior uterine branches. Ovaries in numerous transverse coils in anterior and posterior end of body. Eggs oval, thick shelled, in the early stage of segmentation at deposition, 56 to 65 by 38 to 40 microns in size; shell about 4 microns in thickness.

Location.—Large intestine (cæcum).

Life history.—Not worked out, but possibly similar to that of *Heterakis gallinæ* of poultry, in which case it is simple and direct. Briefly the life history of *H. gallinæ* is as follows: The eggs are passed outside with the fæces of the host. Under

favorable conditions of temperature and moisture, the egg becomes embryonated; that is, a larva is developed inside each egg, and is then infective. If the egg is swallowed by a proper host, hatching takes place in the intestine and the liberated larva soon settles down in the cæcum to grow into an adult. The larvæ do not wander into the lungs as is the case with the larvæ of *Ascaris*.

References.—19, 63.

Superfamily SPIRUROIDEA Railliet and Henry, 1915

Family SPIRURIDÆ Oerley, 1885

Subfamily SPIROXYINÆ Baylis and Lane, 1920

Genus PROTOSPIRURA Seurat, 1914

PROTOSPIRURA MURICOLA Gedoelst, 1916. Fig. 15.

This is possibly the small *Ascaris* which Schöbl (1913) has observed as being not uncommon in the intestine of Philippine rats. Its normal habitat is the stomach, but after the death of the host it often migrates into the small intestine.

The specimens at hand differ greatly among themselves in size, some females in particular being almost twice as large as other females. In the beginning it was thought that the collection represented two species, but it was later revealed that outside of size there were no other morphological differences.

Description.—Body relatively large, regularly attenuated anteriorly. Cuticle transversely striated. Mouth (fig. 15, *b*) with two large lateral lips, each divided into three lobes, of which the middle is larger; each lobe bears two cuticular projections, but no teeth. There are five pairs of head papillæ; namely, one large pair of subventral, a smaller pair of submedian, the dorsal homologues of these, and a minute pair of lateral papillæ. Pharynx (fig. 15, *a*) prominent, laterally compressed, with thick chitinous wall. Œsophagus very elongate, subcylindrical, slightly constricted in region of nerve ring, separated from intestine by valvular apparatus. Cervical papillæ not prominent, in front of nerve ring. Excretory pore ventral, behind nerve ring.

Male 25 to 30 millimeters in length by 0.80 millimeter in maximum thickness at middle of body. Average length of pharynx 0.09 millimeter; of œsophagus 6.20 millimeters. Distance from anterior end to cervical papillæ 0.32 to 0.35 millimeter; to nerve ring 0.38 to 0.41 millimeter; to excretory pore

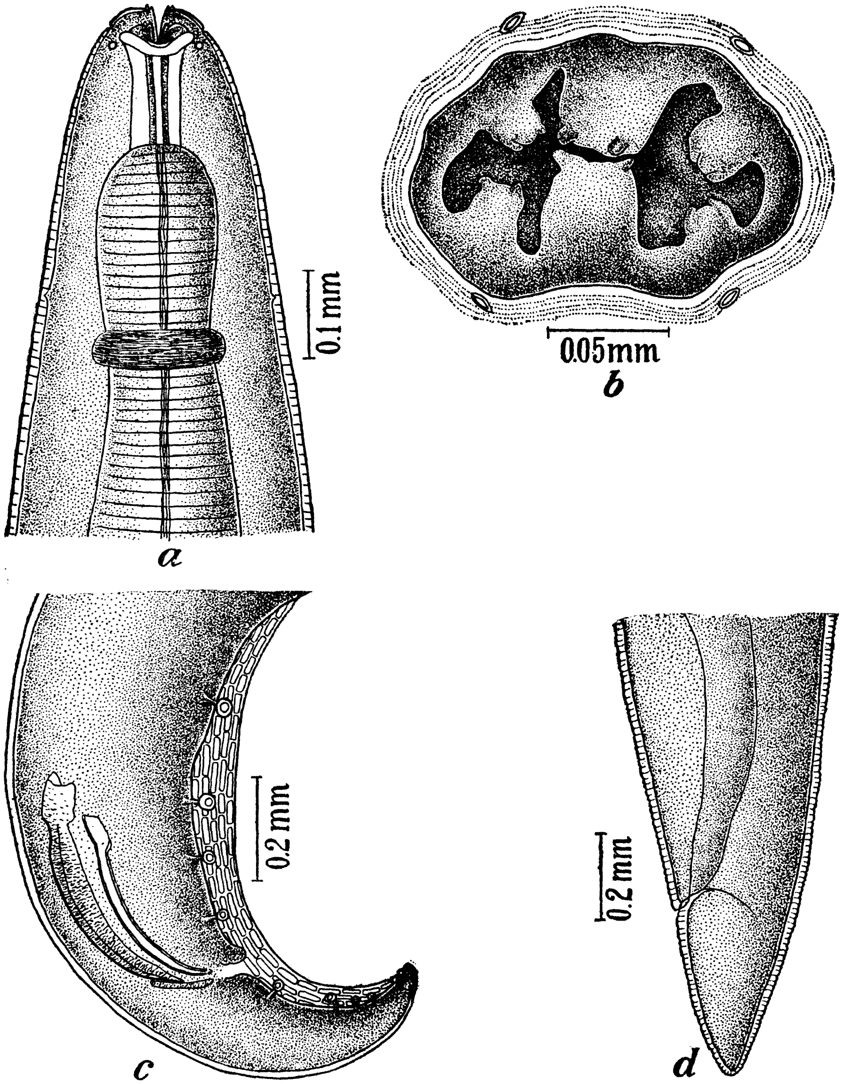

FIG. 15. *Protospirura muricola.* *a*, Anterior end of female, ventral view; *b*, mouth, anterior view; *c*, posterior end of male, lateral view; *d*, posterior end of female, lateral view.

0.43 to 0.45 millimeter. Caudal end of body conical, spiral, carrying moderately developed symmetrical bursa (fig. 15, *c*). Latter with cuticular oblong markings and usually supported by nine pairs of pedunculated papillæ, of which four pairs are larger and preanal in position and five pairs smaller and postanal. Sometimes an extra pair of minute papillæ is present near

tip of tail. Both spicules bent, with enlarged proximal extremities and pointed distal ends, but unequal in size and structure; left spicule spongy, larger, 0.40 to 0.43 millimeter in length by 0.058 to 0.060 millimeter in maximum thickness at proximal end; right spicule hollow, 0.36 to 0.39 by 0.041 to 0.042 millimeter in size. Gubernaculum small, slender, 0.10 millimeter long. Average distance from tip of tail to cloacal opening 0.42 millimeter.

Female 35 to 52 millimeters in length by 1.20 millimeters in maximum thickness at middle of body. Pharynx 0.10 to 0.13 millimeter, œsophagus 6.40 to 7.90 millimeters long. Distance from anterior end to cervical papillæ 0.33 to 0.40 millimeter; to nerve ring 0.38 to 0.47 millimeter; to excretory pore 0.48 to 0.70 millimeter. Caudal end of body bluntly conical (fig. 15, *d*). Anus 0.40 to 0.42 millimeter from posterior end. Vulva a short distance in front of middle of body length. Uteri divergent, anterior uterus reaching anteriorly to almost as far as œsophago-intestinal junction and the posterior uterus extending to a short distance in front of anus. Eggs oval, embryonated at deposition, thick shelled, 50 to 57 by 38 to 44 microns in size.

Location.—Stomach.

Life history.—Probably similar to that of *Protospirura muris* (Gmelin, 1790) and of *P. columbiana* Cram, 1926, in which intermediate hosts are involved. Cram gives the life history of *P. columbiana* as follows: If the embryonated eggs of the parasite are fed to cockroaches (*Phyllodromia germanica*), the liberated larvæ find their way to the body cavity, where they begin to encyst in about a month after feeding. The cysts, however, are not infective at this time. After forty-one days they appear to have reached that stage and if fed to rats the encysted larvæ are capable of pursuing further development in the stomach of the latter. They become fully grown and mature one hundred fifteen days after the feeding of the final host.

References.—6, 9, 19, 40, 63.

Subfamily GONGYLONEMINÆ Hall, 1916

Genus GONGYLONEMA Molin, 1857

GONGYLONEMA NEOPLASTICUM (Fibiger and Ditlevsen, 1914) Ransom and Hall, 1916 Figs. 16 and 17.

Synonym: *Spiroptera neoplastica* Fibiger and Ditlevsen, 1914.

Two species of the genus *Gongylonema* have been reported from rats; namely, *G. neoplasticum* and *G. orientale* Yokogawa,

1925. They are said to differ from each other in the following respects: Morphologically, in total size, length of œsophagus, spicules and vas deferens, structure of the spermatozoa, size of the eggs, etc; biologically, in the time necessary for the sexes to reach maturity in experimental infestations. In view, however, of the observations of Seurat (1916) and Baylis (1925) on the degree of morphological variations exhibited by members of the genus, it is not unlikely that the two rodent parasites are identical. Baylis even goes further in suspecting that *G. neoplasticum* is similar to *G. pulchrum* of the pig, between which the differences are much greater and, therefore, more apparent. This, however, could hardly be the case, for, if it were so, it would be difficult to explain why a parasite that is so common in rats has not yet been reported in Philippine domesticated animals. The writer has looked for *G. pulchrum* with uniformly negative results in swine, sheep, goats, and cattle.

This parasite has received considerable attention due to the report of Fibiger and Ditlevsen (1914) that it is instrumental in the production of carcinomatous growths in rats. In the present survey this possible rôle of the parasite was kept constantly in mind, but of the rats found harboring it not one presented a gastric tumor. The condition must be rare in Philippine rats, for Schöbl (1913), who examined tens of thousands of these animals in connection with plague, records only one case of tumor located on the large curvature of the stomach. No determination was made as to the possible origin of the new growth.

Description.—Body long, slender, threadlike, terminating in a blunt cone anteriorly. Cuticle transversely striate; bears in cephalic and œsophageal regions more or less globular, egg-shaped or sausage-shaped cuticular plaques or bosses, of variable size and arranged irregularly in longitudinal rows on body surface (fig. 16). Lateral bands present, extending on both sides throughout body length except at most anterior and most posterior regions. Cervical papillæ inconspicuous, in front of nerve ring. Excretory pore ventral, behind nerve ring. Mouth small, surrounded by four very inconspicuous lips; buccal rim 0.02 to 0.03 millimeter in diameter. Œsophagus very long, in two parts—anterior muscular and posterior glandular— separated from intestine by constriction and intestinal valves.

Male 11.0 to 12.0 millimeters in length by 0.20 millimeter in maximum thickness at middle of body. Pharynx 0.05 millime-

ter long. Anterior portion of œsophagus 0.4 millimeter long, posterior portion 2.4 millimeters; total length of œsophagus, therefore, about one-fourth of total body length. Distance from anterior end of worm to cervical papillæ 0.13 millimeter, to nerve ring 0.22 millimeter, to excretory pore 0.34 millimeter. Tail (fig. 17, *a*) slightly twisted on its long axis, provided with asymmetrical alæ, the left wing being usually longer than the right. Eight pairs of pedunculated caudal papillæ present, of which four pairs are slightly larger and preanal and four pairs postanal; last postanal pair very minute; at least a pair of sessile papillæ often present near tip of tail. Spicules very dissimilar; short one usually on the right, sword-shaped, 0.125 by 0.015 millimeter in size; left spicule filiform, 0.740 millimeter long, of nearly uniform thickness (0.006 millimeter) throughout except at proximal end, where it is dilated. Gubernaculum asymmetrical, 0.065 millimeter long.

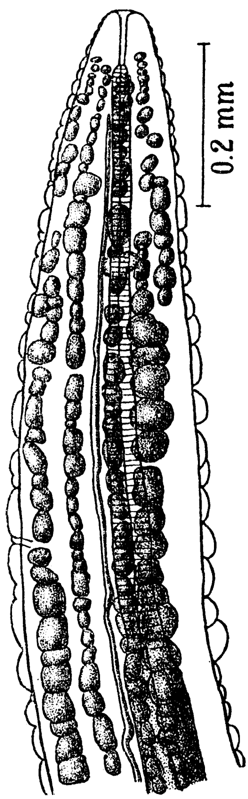

FIG. 16. *Gongylonema neoplasticum*, anterior end, lateral view.

Female 35.0 to 70.0 millimeters in length by 0.20 to 0.35 millimeter in thickness at middle of body. Posterior end behind anus formed into a pointed, ventrally curved tail (fig. 17, *b*). Pharynx 0.058 to 0.072 millimeter long. Anterior portion of œsophagus 0.46 to 0.78 millimeter long, posterior portion 4.0 to 7.6 millimeters; total length of œsophagus 4.5 to 8.4 millimeters or about one-eighth to one-ninth of total body length. Distance from anterior end of worm to cervical papillæ 0.13 to 0.16 millimeter, to nerve ring 0.23 to 0.25 millimeter, to excretory pore 0.60 to 0.66 millimeter. Vulva not prominent, behind middle of body. Distance from tip of tail to vulva 2.6 to 5.9 millimeters, and to anus 0.17 to 0.21 millimeter. Vagina short, directed anteriorly from vulva and followed by long ovejector. Uteri divergent; anterior uterus becomes receptaculum seminis near posterior end of œsophagus, the posterior uterus being similarly modified behind level of vulva. Ovaries much coiled. Eggs oval, embryonated at deposition, 54

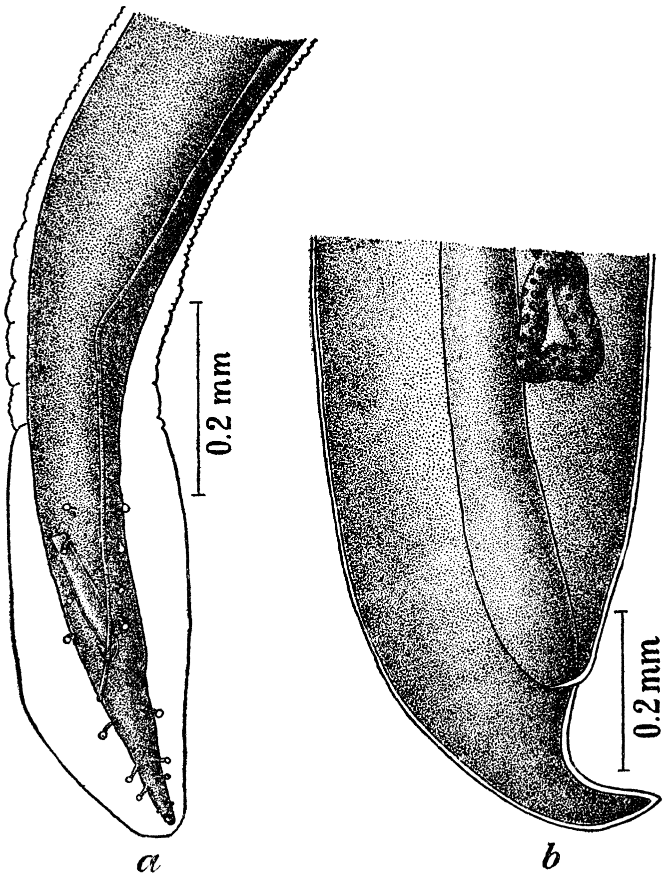

FIG. 17. *Gongylonema neoplasticum.* *a*, Posterior end of male, ventral view; *b*, posterior end of female, lateral view.

to 56 by 34 to 36 microns in size, with smooth shell about 3 microns in thickness.

Location.—Squamous-celled anterior portion of digestive tract, usually beneath gastric mucosa.

Life history.—The development of this parasite requires an intermediate host, which is invariably an insect. Cockroaches, such as, *Blatta orientalis, Phyllodromia germanica,* and *Periplaneta americana;* dung beetles, such as, *Ateuchus, Aphodius,* and other genera of the family Scarabæidæ; cellar beetles and mealworm beetles of the family Tenebrionidæ are all possible intermediate hosts. Hall (1916) describes the life history as follows: The eggs of the worm are passed out of the body in desquamations of the epithelium of the digestive tract with the

fæces. If ingested by any one of the above insects, they hatch in the intestine, and the liberated embryos, which measure 250 by 13 microns, follow a certain route and are finally found encapsulated in the musculature of the prothorax and legs of the intermediary host. At this stage the larvæ are 0.792 to 1.215 millimeters long and are coiled in spirals within their individual cysts. They are rather slender and possess a conical tail that often terminates in two or three papillalike projections of variable size. Occasionally a wing-shaped prominence with fringed or serrate edges is present. Anteriorly the larvæ are very similar in appearance to the mature worms, except that the pharynx is relatively longer than in the adult and the œsophagus is nearly as long as the intestine. In the beginning the growth of the encapsulated larvæ is faster towards the anterior end, but later the rate of growth is reversed. The nerve ring and excretory pore are distinct, the latter located halfway between the former and the union of the two portions of the œsophagus. Near the region where the vulva will later develop in the female, the anlage of the reproductive system appears in the form of an oval body consisting of a number of cells or a syncytium with several nuclei.

If an insect harboring these encysted larvæ is ingested by a proper vertebrate host, such as a rat, the latter are liberated from their capsules due no doubt to the action of the gastric juice, and on the following day they will be found to have penetrated into the mucous membrane of the stomach and sometimes also into that of the œsophagus and tongue. During the first ten days growth is rather slow, the larvæ only doubling their original length. They molt at about this time and their tails become simple like those of the adult worms. Then they grow more rapidly, and after two months the females begin to deposit eggs.

References.—4, 5, 19, 40, 43, 63.

Family RICTULARIIDÆ Railliet, 1916

Subfamily RICTULARIINÆ Hall, 1913

Genus RICTULARIA Froelich, 1802

RICTULARIA WHARTONI sp. nov. Fig. 18.

This nematode is named in honor of the late Mr. Lawrence D. Wharton, one of the early pioneers in the field of parasitology in the Philippine Islands.

Description.—Male unknown.

Female 25 to 33 millimeters in length by 0.65 to 0.90 millimeter in thickness across middle of body. Cuticle transversely striated, often swollen anteriorly forming a pair of ventrolateral cuticular expansions 0.40 to 0.90 millimeter long (fig. 18, *a*). Anterior end bent ventrally in preserved specimens, the rest of body length turned towards opposite direction or rolled into a semicircle; posterior end conical, ending in a short fine point (fig. 18, *c*). Head 0.145 to 0.195 millimeter in thickness across base of buccal capsule, provided with two ventral papillæ. Buccal capsule well developed, 0.05 to 0.07 by 0.06 to 0.08 millimeter in size, with its aperture surrounded by a series of denticles (corona radiata) and its base armed with three conical teeth possessing serrated borders (fig. 18, *b*). Œsophagus 3.5 to 4.6 millimeters long. Nerve ring 0.30 to 0.35 millimeter from anterior end. Cervical papillæ not very conspicuous, 0.70 to 0.74 millimeter from anterior end. There are 42 to 43 pairs of "combs" extending from the head to the level of the vulva and measuring 0.045 by 0.015 to 0.200 by 0.145 millimeter; first pair of "combs" almost ridgelike, the rest bigger, more distinct and gradually becoming more spinelike (fig. 18, *a*). Behind the vulvar level there are 47 to 50 pairs of spines 0.05 to 0.16 millimeter long, the first three or five pairs being really of a transitional type and the most posterior pair shorter; last pair of spines immediately behind level of anal opening. Vulva moderately prominent, usually in front (0.3 millimeter) of level of posterior end of œsophagus, occasionally directly opposite or even slightly behind this level. Vagina directed posteriorly from vulva. Uteri convergent. Eggs with smooth fairly thick shell, embryonated at time of deposition, measuring 44.2 to 47.5 by 34 microns. Anus 0.215 to 0.270 millimeter from tip of tail.

Specific diagnosis.—Rictularia: Male unknown. Female 25 to 33 millimeters in length by 0.65 to 0.90 millimeter in maximum thickness; with a pair of ventrolateral cuticular dilatations in cervical region. Base of buccal capsule armed with three conical teeth possessing serrated borders. Œsophagus 3.5 to 4.6 millimeters long; distance from anterior end to nerve ring 0.30 to 0.35 millimeter; to cervical papillæ 0.70 to 0.74 millimeter. Forty-two to forty-three pairs of "combs" from head to level of vulva and forty-seven to fifty pairs of spines from immediately behind vulvar level to posterior end of body. Vulva usually in front of posterior end of œsophagus. Anus 0.215 to 0.270 millimeter from tip of tail. Eggs 44.2 to 47.5 by 34.0 microns in size.

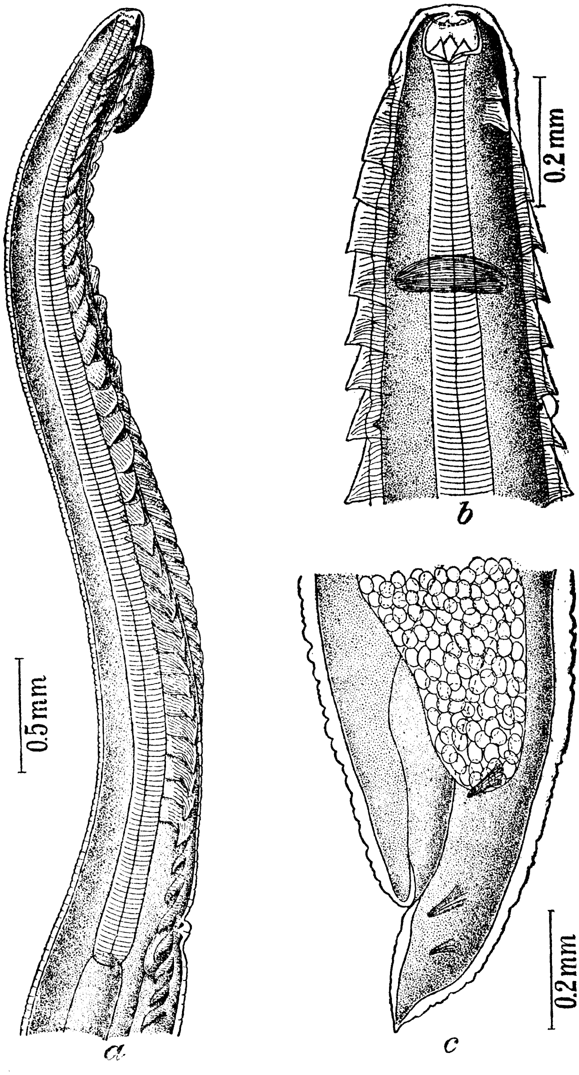

FIG. 18. *Rictularia whartoni* sp. nov. *a*, Anterior end of female, lateral view; *b*, anterior end of female, ventral view; *c*, posterior end of female, lateral view.

Location.—Stomach and small intestine.

Locality.—Manila, P. I.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 10.

Life history.—Unknown.

Reference.—6, 19, 63.

Class ACANTHOCEPHALA Rudolphi, 1808

Order ECHINORHYNCHATA Faust, 1929

Family MONILIFORMIDÆ Van Cleave, 1924

Genus MONILIFORMIS Travassos, 1915

MONILIFORMIS MONILIFORMIS (Bremser, 1811) Travassos, 1915. Fig. 19.

Synonyms: *Echinorhynchus moniliformis* Bremser, 1811; *Gigantorhynchus moniliformis* (Bremser, 1811) Railliet, 1893; *Hormorhynchus moniliformis* (Bremser, 1811) Ward, 1917; *Echinorhynchus cestodiformis* Linstow, 1904.

This is appropriately known in ordinary language as the beaded thorn-headed worm. In the adult stage it is a common parasite of rats and other rodents and occasionally of dog and man. Calandruccio (1888), who infected himself experimentally by ingesting several infective larvæ, was able to demonstrate that the presence of the parasite in man in large numbers may produce diarrhœa and severe gastrointestinal pain accompanied by exhaustion, somnolence, and ringing of the ears. The expulsion of the worms with male fern caused the symptoms to disappear two days after the treatment.

Description.—Body whitish or creamy-white in color, attenuated at both extremities, divided superficially except at extreme anterior and posterior ends by annular grooves into a series of beadlike pseudo-segments that give the worm a moniliform appearance. Size very variable in both sexes, the smallest specimens usually immature. Proboscis (fig. 19, *a*) cylindrical, protrusible, relatively short, with broadly rounded distal end; 0.425 to 0.670 by 0.15 to 0.21 millimeter in size, armed with 12 to 16 longitudinal rows of recurved hooks, each row composed of 7 to 12 hooks; hooks 24 to 30 microns long, each with a single posteriorly directed root process (fig. 19, *b*). Proboscis sheath large, 0.5 to 1.3 by 0.22 to 0.42 millimeters in size, its wall composed of two muscular layers, of which the outer is made up of diagonally wound fibers. Lemnisci filiform, 2.4 to 10.0 millimeters long, with few large nuclei.

Male 5.5 to 86.0 millimeters in length by 1.0 to 1.5 millimeters in maximum breadth at middle of body; posterior end expanded into small bell-shaped bursa copulatrix, which, however, is usually retracted within the body, being forced out only during the copulatory act or as the result of the contraction of the wall during the preservation of the specimen. Reproductive organs

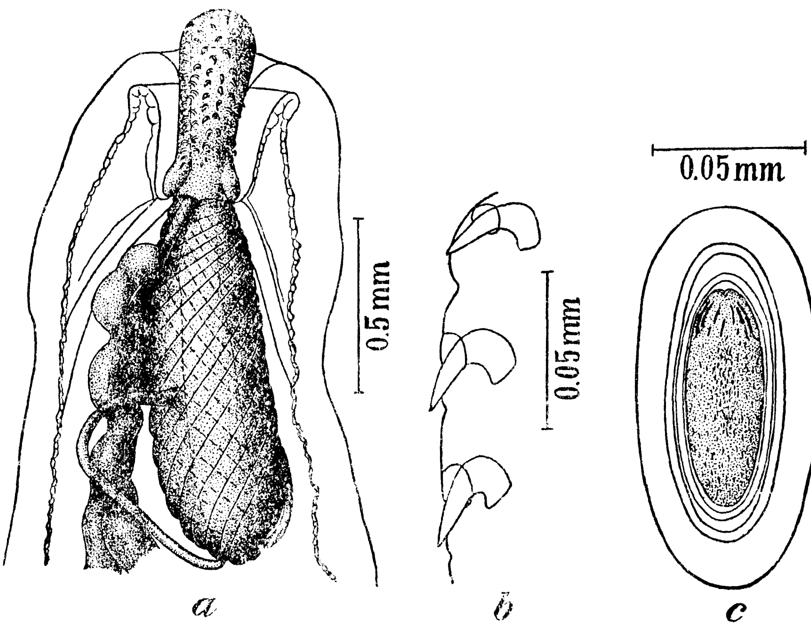

FIG. 19. *Moniliformis moniliformis*. *a*, Anterior end, lateral view; *b*, hooks; *c*, egg.

at posterior portion of body cavity. Testes, of which there are two, are oval, elongated, one immediately behind the other, 0.2 to 4.0 (usually 2.0) by 0.12 to 0.96 millimeters in size. Prostatic glands eight in number, roundish to oval in shape, compressed and crowded together behind testes, the entire mass measuring in mature worms 0.45 to 3.60 by 0.25 to 1.10 millimeters.

Female 7 to 270 by 1.5 millimeters in size. Ovary present only in larval stage, produces large numbers of ova which later are found free in the body cavity of the adult worm. Eggs ellipsoidal, 109 to 137 by 40 to 63 microns in size, and provided with three envelopes; in fully mature eggs outer shell slightly wrinkled and the inclosed embryo brown or dark-colored, striated and covered with minute spines (fig. 19, *c*).

Location.—Small intestine.

Life history.—Indirect, the intermediate hosts being species of beetles (*Blaps mucronata*), cockroaches (*Periplaneta americana*), and possibly other insects. If ingested by these insects the eggs develop into oval larvæ in their abdominal cavities. Each larva is inclosed in a very delicate cyst, which, according to Southwell (1922) is easily lost. The larva on being swallowed by a suitable mammalian host together with the insect har-

boring it escapes from its cyst (if this has not already been lost) and develops directly into an adult worm. The mode of infection in man is somewhat obscure; it may result from the accidental ingestion of either of the infected intermediate host or food polluted by cysts from disintegrated cockroaches and beetles.

Prevention.—Consists in the destruction of rats and mice that play the rôle of reservoirs and of cockroaches and beetles that act as intermediate hosts of the parasite. Foods should be protected from these insects.

References.—14, 46, 47, 51, 53, 54, 56.

SUMMARY

Besides the rôle that they play as carriers and reservoirs of bubonic plague and other bacterial as well as spirochætal infections, rats often harbor parasitic worms, some of which are also a menace to human health. In view of this and because of the fact that the helminthic fauna of rats has never been studied extensively in the Philippine Islands, it seemed desirable to undertake a systematic examination of these animals for the purpose of finding out if they are infested with parasites that are transmissible to man.

The examination of nine hundred fifty rats (*Mus norvegicus*) resulted in the identification of the following sixteen species of helminths: Trematodes: *Euparyphium ilocanum, E. guerreroi,* and *E. murinum* sp. nov.; cestodes: *Tænia tæniaformis* (larval form), *Raillietina garrisoni* sp. nov., *Hymenolepis diminuta,* and *H. nana;* nematodes: *Gongylonema neoplasticum, Hepaticola hepatica, Heterakis spumosa, Nippostrongylus muris, Protospirura muricola, Rictularia whartoni* sp. nov., *Strongyloides ratti* and *Trichosomoides crassicauda; Acanthocephala: Moniliformis moniliformis.*

The following parasites of rats have been reported from human beings: *Euparyphium ilocanum, Hymenolepis diminuta, H. nana, Syphacia obvelata, Hepaticola hepatica,* and *Moniliformis moniliformis.* The first four species mentioned in this paragraph have been reported to occur in man in the Philippine Islands.

It is also believed that *Raillietina garrisoni* should be included among the parasites of the rat that are transmissible to man because of its common occurrence and its close morphological

resemblance to the human tapeworm described by Garrison in 1911 from the Philippines as *Davainea madagascariensis.*

The morphology and the life history, if known, of each of the different parasites are given and, in the case of the forms that are transmissible to man, methods of avoiding infestation are discussed.

ADDENDUM

After the manuscript of the above paper was submitted for publication, I found in the literature a description by Hoeppli [2] of a new nematode, *Rictularia tani,* from the brown rat in Amoy, China, with which *Rictularia whartoni* Tubangui should be compared. The two forms resemble each other in several important characters, such as, in the number of their cuticular combs and spines, the length of the œsophagus, and the location of the nerve ring, vulva and anus. They differ in the presence of a pair of ventrolateral cuticular dilatations in *R. whartoni* and in the fact that the last pair of spines of *R. whartoni* is found behind the anus, that of *R. tani* occurring in front of that level. Because of these differences it is decided to maintain the Philippine *Rictularia* as a separate species.

Very recently there also came to hand a paper by Lopez-Neyra [3] that has an important bearing on the discussion of *Raillietina garrisoni.* I described this as a new species of rat tapeworm for, while recognizing its close alliance to *Raillietina celebensis* (Janicki) Meggitt and Subramanian, 1927, it differs from the latter in the number of its testes and uterine egg capsules and in the size of its cirrus pouch. I also gave reasons for suspecting its possible identity with Garrison's *Davainea madagascariensis* which, according to Joyeux and Baer, differs from the specimens described under the same name by other observers. Now, according to Lopez-Neyra, the following represent one and the same species of parasite that should be known as *Kotlania madagascariensis* (Davaine, 1869): the collections in the Parasitological Laboratory of the University of Paris denominated as Type No. 108 (Davaine), No. 109 (Davaine), No. 8 (Blanchard, Port-Louis) and No. 33 (Nossi-Bè, 1873); *Taenia madagascariensis* Leuckart, 1891; *Davainea madagascariensis* Garrison, 1911; *D. formosana* Akashi, 1916; *Raillietina*

[2] Centralbl. f. Bakteriol. u. Parasitenk. 1 Abt. Orig. 110 (1929) 75–78.

[3] Ann. Parasit. Hum. et Comp. 9 (1931) 162–184.

celebensis (Janicki) Meggitt and Subramanian, 1927; *R. funebris* Meggitt and Subramanian, 1927; and possibly *R. fluxa* Meggitt and Subramanian 1927. If Lopez-Neyra's hypothesis is accepted, then *Raillietina garrisoni* will have to fall in line with the above synonymy.

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ILLUSTRATIONS

[Drawn by V. V. Marasigan under the direction of the author.]

TEXT FIGURES

FIG. 1. *Euparyphium ilocanum.* *a,* Entire worm, ventral view; *b,* anterior end, showing arrangement of spines on cephalic collar, ventral view. (After Tubangui, 1931.)

2. *Euparyphium guerreroi.* *a,* Entire worm, ventral view; *b,* anterior end, showing arrangement of spines on cephalic collar, ventral view. (After Tubangui, 1931.)

3. *Euparyphium murinum* sp. nov. *a,* Entire worm, ventral view; *b,* anterior end, showing arrangement of spines on cephalic collar, ventral view.

4. *Tænia tæniaformis.* *a,* Entire larva (after Sambon, 1924); *b,* scolex, anterior view; *c,* rostellar hooks.

5. *Raillietina garrisoni* sp. nov. *a,* Rostellar hooks; *b,* scolex; *c,* mature segment; *d,* gravid segment; *e,* egg.

6. *Hymenolepis diminuta.* *a,* Head; *b,* mature segment, dorsal view; *c,* gravid segment; *d,* egg.

7. *Hymenolepis nana.* *a,* Entire worm (from Ransom, 1904); *b,* rostellar hooks.

8. *Hymenolepis nana.* *a,* Head; *b,* mature segment, ventral view; *c,* gravid segment; *d,* egg.

9. *Strongyloides ratti,* entire worm. *a,* Anus, *oe,* œsophagus; *ov,* ovary; *v,* vulva.

10. *Trichosomoides crassicauda.* *a,* Mature female with male in uterus (after Hall, 1916), *m,* male worm; *v,* vulva; *b,* anterior end of mature male (after Thomas, 1924); *c,* egg.

11. *Hepaticola hepatica.* *a,* Anterior end of mature female (after Nishigori, from Yorke and Maplestone, 1926); *oe,* œsophagus; *v,* vulva; *b,* egg.

12. *Nippostrongylus muris.* *a,* Anterior end, lateral view; *b,* bursa, dorsal view.

13. *Syphacia obvelata.* *a,* Anterior end of female, lateral view; *b,* male, lateral view; *c,* posterior end of male, ventral view; *d,* posterior end of female, lateral view; *e,* egg. (All from Yorke and Maplestone, 1926.)

14. *Heterakis spumosa.* *a,* Anterior end of female, ventral view; *b,* posterior end of female, lateral view; *c,* posterior end of male, ventral view.

15. *Protospirura muricola.* *a,* Anterior end of female, ventral view; *b,* mouth, anterior view; *c,* posterior end of male, lateral view; *d,* posterior end of female, lateral view.

16. *Gongylonema neoplasticum,* anterior end, lateral view.

17. *Gongylonema neoplasticum.* *a,* Posterior end of male, ventral view; *b,* posterior end of female, lateral view.

18. *Rictularia whartoni* sp. nov. *a,* Anterior end of female, lateral view; *b,* anterior end of female, ventral view; *c,* posterior end of female, lateral view.

19. *Moniliformis moniliformis.* *a,* Anterior end, lateral view; *b,* hooks; *c,* egg.

NOTES ON DENGUE

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TWO TEXT FIGURES

The question of immunity in dengue has been discussed on innumerable occasions and much research work has been done on this phase of the disease. That immunity to the disease does occur was reported by Simmons, St. John, and Reynolds,[1] they reporting an effective resistance to reinfection in the case of thirty-six volunteers who had previously suffered from experimentally induced attacks of dengue. The immunity was proven in these cases at periods from one-half to thirteen months after the attack. This finding has been supported by experimental work carried on by the authors in six cases, all proving immune to the same strain with which they were originally infected twenty days previously. Following the proof of this immunity an attempt was made to reinfect these volunteers by feeding on them mosquitoes that had been infected by feeding on two other cases of dengue fourteen days previously. Reinfection was not accomplished in any of the six cases although they were all held twenty-one days after being bitten by the mosquitoes infected from an outside source.

This attempt to reinfect from outside sources was suggested by two cases that came under our observation and that, coupled with the fact that so many cases are immune to the virus with which they were originally infected, led us to suspect that there might possibly be different strains of dengue virus. We still believe in that possibility and attempts are being made to secure dengue-infected mosquitoes from other localities to prove or disprove this possibility.

The two cases mentioned above have the following histories:

1. This case was an officer's wife who arrived in the Philippine Islands in March, 1930, and has lived in Manila since

[1] Philip. Journ. Sci. 44 (1931) 174.

that time. She developed dengue in March, 1930, July, 1930, and October, 1930. All three attacks were typical and severe. There was a marked reduction in the leucocyte count, a crossing of the staff and segmented leucocytic curves and a temperature curve characteristic of the disease. In spite of the fact that transmission experiments were not carried out, all other findings strongly supported the belief that in this case three attacks of dengue occurred in less than seven months.

2. This case was a volunteer who was kept in a screened cubicle in Sternberg General Hospital for eight days, preliminary observation, during which time no symptoms of illness appeared. On the ninth day this volunteer was bitten by fifty mosquitoes selected at random from a cage of five hundred insects that had been infected from an experimentally induced case of dengue eighteen days previously. Three other volunteers were infected at the same time by the bites of other insects from the same lot and all three developed typical dengue. The case in discussion did not develop dengue after fourteen days, and forty-six mosquitoes of another infected lot were allowed to bite him. During three weeks observation following the second feeding no dengue occurred and he was discharged from hospital as immune. During his stay in hospital he had been transferred to a station 30 miles outside Manila and joined that station immediately after leaving hospital. Fourteen days after joining his new station he developed a typical case of dengue, as was shown by blood findings and clinical symptoms. There was no question as to the infectivity of the two lots of mosquitoes used in this case, and it is not believed that infection could have been produced as a result of feeding upon him the last lot of mosquitoes thirty-five days previously. No such prolonged incubation period has been observed, the vast majority of cases developing the disease within eight days after infection. There are only three possible conclusions in this case: (1) The extremely remote contingency that there was a long delayed incubation period after the second infection by mosquitoes; (2) that he lost a high degree of immunity in about twenty-nine days (allowing six days incubation period for the development of the disease); (3) that there are different strains of dengue virus.

Our experience and the experience of others lead us to believe that the first conclusion is practically untenable and that the second is not probable.

The first case related has no parallel insofar as we have been able to find, this patient having had three proven attacks of

dengue, severe in character, in a period of seven months. The evidence in these two cases certainly leads us to suspect the possibility of strains of dengue virus. Other cases not so striking as are these two tend to confirm our belief.

St. John [2] has devised a feeding cell so constructed that normal mosquitoes may be fed on other mosquitoes ground up and suspended in blood. In an attempt to attenuate the virus of dengue we have made serial feedings of normal *Aëdes ægypti* on macerated infected *Aëdes*, using fifty infected mosquitoes ground up in one cubic centimeter of nonimmune blood. These *Aëdes* infected by feeding were allowed an incubation period of fourteen days when they in turn were fed to normal *Aëdes* in the same manner as above. Five transfers were made and in all cases the insects were well filled with the blood mixture after feeding. Fourteen days after the third transfer dengue was produced in a susceptible volunteer, showing that transfer from mosquito to mosquito can be accomplished at least three times without the intervention of a human host. It is unlikely, of course, that this occurs in nature. The dengue produced by the bites of mosquitoes that had been infected by the third serial transfer from insect to insect was not modified insofar as we could determine, there being a reduction of the total white count to five thousand per cubic millimeter, a maximum temperature of 104° F., and a typical crossing of the segmented and staff forms of leucocytes. The subjective symptoms were as severe as in the ordinary attack of dengue. Fourteen days after the fifth serial transfer one hundred forty-five mosquitoes of this lot were allowed to bite a susceptible volunteer and did not produce dengue in twenty days. Subsequently this volunteer was bitten by a known infected lot of mosquitoes and developed typical dengue, showing that the volunteer was not immune and that the dengue virus had been lost in the five direct transfers from mosquito to mosquito or that it had been attenuated to such an extent that infection did not occur.

In another series of experiments attempts to attenuate the virus were made as follows:

Two volunteers were subjected to a preliminary observation period of one month in a screened cubicle. Dengue was produced experimentally in a third volunteer and on the first day of the fever 10 cubic centimeters of blood was removed, allowed to clot, the serum separated and immediately frozen at a tem-

[2] Op. cit., Plate 2.

perature of — 7° F. Twenty-four hours later 0.3 cubic centimeter of this serum was injected subcutaneously into the first volunteer and forty-eight hours after freezing 0.3 cubic centimeter of the same serum was injected into the second volunteer. The results obtained in the volunteer who received 0.3 cubic centimeter of the serum that had been frozen twenty-four hours were inconclusive in that the incubation period was too short to be entirely certain of the source of the infection, but in the volunteer receiving the virus frozen for forty-eight hours the disease developed on the seventh day and was typical, as shown by fig. 1.

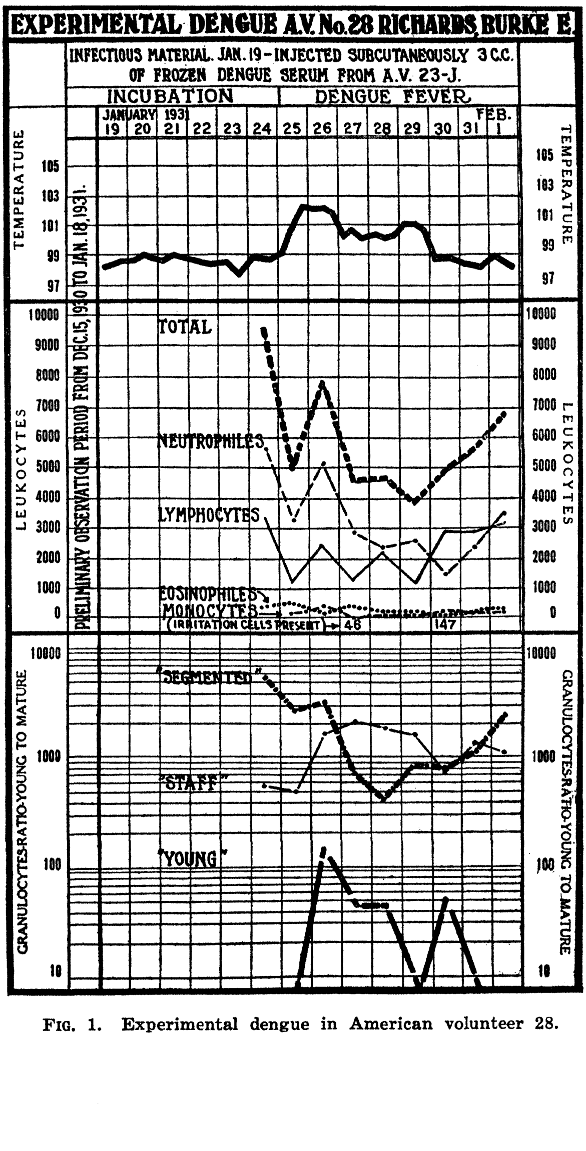

FIG. 1. Experimental dengue in American volunteer 28.

From this experiment it seems certain that the virus of dengue is affected little, if at all, by freezing at — 7° F. for a period of forty-eight hours.

A number of investigators have attempted to modify the course of dengue by the use of "convalescent" serum and all report failures. We have gone a step further. From each of four volunteers who had recovered from experimental dengue 10 cubic centimeters of plasma was removed on the fourteenth day after fever had disappeared. The pseudoglobulins were precipitated out of the pooled plasma, diluted with 0.85 per cent salt solution, and injected into a volunteer on the first day of dengue. No modification of the disease was noted. As shown by the chart, fig. 2, there was a primary and secondary rise of temperature, the height of the first reaching 103° F. and the

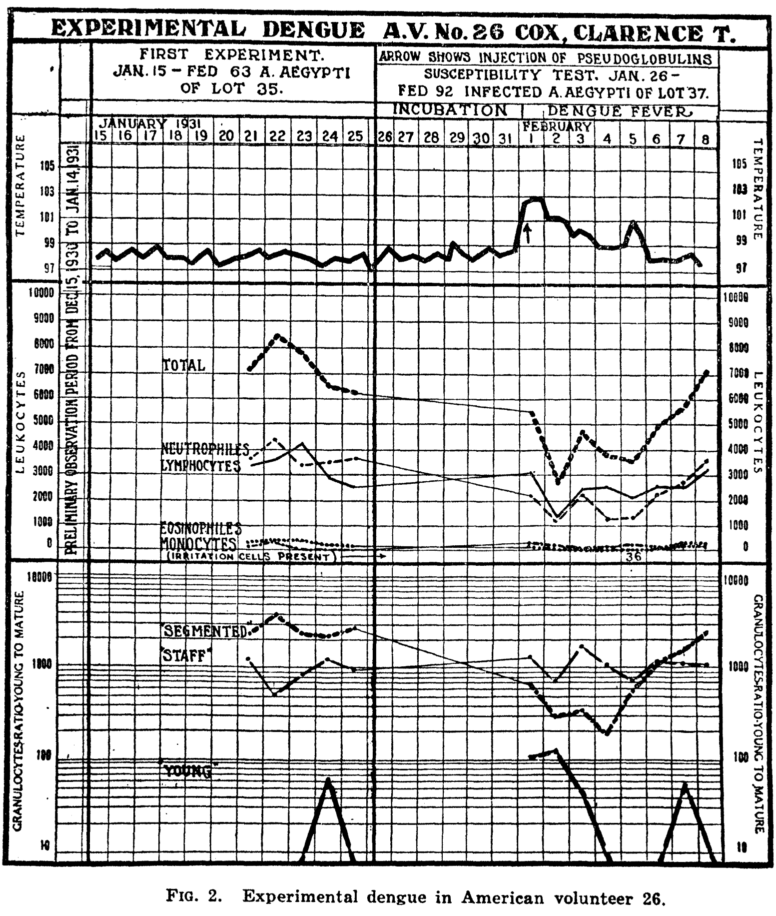

FIG. 2. Experimental dengue in American volunteer 26.

second 101° F. There was no discoverable abatement of the subjective symptoms, and none of the other symptoms seemed to be modified.

CONCLUSIONS

There is certainly an immunity to dengue fourteen days after an attack, both to the original infecting medium and to the virus of two outside cases.

Peculiarities in the behaviour of attacks of dengue, two cases of which are reported, coupled with the fact that immunity to the homologous strain has been proven numbers of times lead us to believe in the existence of "strains" of dengue virus.

The virus of dengue was tranferred from mosquito to mosquito by feeding for three transfers but was lost before the fifth transfer.

There was no discoverable attenuation of the virus as a result of the three transfers above mentioned.

Freezing dengue serum at — 7° F. for forty-eight hours did not destroy the virus nor was it attenuated insofar as we could discover.

Concentrated "immune bodies" from the serum of recovered cases of dengue do not affect the course of the disease when injected on the first day of the attack.

ILLUSTRATIONS

TEXT FIGURES

RESISTANCE OF DENGUE VIRUS

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FOUR TEXT FIGURES

Considering the enormous amount of work that has been done on dengue, it is rather surprising to note that comparatively little has been done on the resistance of dengue virus to outside influences. Cleland, Bradley, and McDonald [1] were able to produce dengue by inoculating infective blood which had been stored at refrigerator or room temperature for periods up to 172 hours. Blanc and Caminopetros [2] found that the addition of relatively small amounts of bile killed the virus in a short time. The virus has been preserved for periods of several days by different methods but almost always at low temperature. Drying of the virus seems to destroy it much more quickly than when it is kept moist and subjected to the same procedures. A temperature of 55° C. will render the virus noninfective within a period well under thirty minutes. It is certain that the virus resists the actions of the body fluids for an incubation period of six to nine or ten days and for at least three days after the onset of the disease. The mixing of convalescent sera and virus in serum does not seem to affect the infective power of the virus. It is well established that the virus lasts throughout the life of the infected *Aëdes*. We have demonstrated that the virus does not remain infective at the end of seven days at 37.5° C. in Tyrode's medium alone or with the addition of fresh testicular tissue from a rabbit. At just what period it lost its infectivity we are unable to say. We have already reported that freezing dengue serum at – 7° C. for a period of forty-eight hours does not seem to affect its infective power in the least.

Since it is well known that ultra-violet rays will destroy bacteria of many kinds in water and that X-rays will destroy the spores of many of the fungi, it was decided that it was worth

[1] Journ. Hyg. Cambridge **18**: 217.

[2] Bull. Acad. Med. Athens **26**: 37.

while to see if either of these agents would affect the virus of dengue in the body of the mosquito. As a preliminary step it was necessary to determine the resistance of *Aëdes ægypti* to the effects of X-ray and ultra-violet light. The insects were placed in a glass feeding cell, the open end of which was covered with mosquito netting to allow passage of the rays. In all exposures the number of insects used was twenty-five. In X-ray exposures the setting of the machine was constant; namely, 70 K.V., 5 M.A. and the distance from the center of the feeding cell was 30 centimeters. Only the time varied. Almost all of the mortality among the insects exposed occurred within a few minutes of the exposure and the mortality was not even roughly proportional to the length of exposure. For instance, when exposed to approximately one-twelfth erythema dose (30 seconds) four insects were dead in fifteen minutes and only two more had died at the end of twenty-four hours, one-sixth erythema dose (60 seconds) showed five dead in fifteen minutes and only two more dead in twenty-four hours, one-third erythema dose (90 seconds) showed eight and eleven dead, while one-half erythema dose (3 minutes) showed figures of two and naught. In this manner it was found that these insects could readily stand as much as two erythema doses with about 50 per cent living after twenty-four hours. A few lived for several days after this exposure.

TABLE 1.—*Aëdes ægypti exposed to X-ray.*

Setting.	Number exposed.	Time.	Distance.	Living at end of—	
				15 minutes.	24 hours.
		sec.	*cm.*		
70 KV-5 MA	25	30	30	21	19
70 KV-5 MA	25	60	30	20	18
70 KV-5 MA	25	90	30	17	14
70 KV-5 MA	25	180	30	23	23

In the same manner experiments were carried out to show the effects of ultra-violet on the normal *Aëdes*. The source of the ultra-violet was a Cooper Hewitt unit. The container for the mosquitoes in all experiments was a round glass feeding cell 14 centimeters deep with the open end toward the source of light covered by mosquito netting. In all cases there were 65 volts

across the arc of the mercury lamp and the current was 3.5 amperes.

This arc gave light of a total energy at 40 centimeters of 22 microwatts per square millimeter, or 0.000005 gram calories per second per square millimeter.

The light had the following spectral characteristics:

Millimicrons.	Per cent.	Microwatts per square millimeter.
185–1400	100	22
250–1400	78	17
310–1400	66	15
185–250	22	5
185–310	34	8
250–310	12	3

With an exposure of fifteen minutes at a distance of 40 centimeters, thirty-four insects showed no ill effects in seventy-two hours.

With thirty minutes exposure at 25 centimeters distance, of twenty-five mosquitoes two were dead at the end of the exposure and seven more were dead at the expiration of thirty minutes after the exposure. These deaths may have been due to heat or ultra-violet or both.

Of thirty-four mosquitoes exposed for one hour at a distance of 18 centimeters, with the light filtered through 4 millimeters of quartz and 1 centimeter of water and screened from the heat of the lamp, nine were dead in twenty-four hours and twenty-five were living but very weak. At the end of forty-eight hours thirty-three were dead and one was living but very weak.

With a forty-five minute exposure under the same conditions, of thirty mosquitoes two were living and twenty-eight dead at the end of twenty-four hours, and at the end of forty-eight hours all were dead.

Of twenty-five mosquitoes exposed for thirty minutes under the same conditions as related in the preceding experiment, fourteen were living at the end of twenty-four hours, three were living at the end of forty-eight hours, one was living at the end of seventy-two hours, and all were dead at the end of ninety-six hours. The fourteen living at the end of twenty-four hours were so weak that they were unable to feed on an animal.

To the ultra-violet that had passed through 4 millimeters of quartz, 1 centimeter of water and 2.5 millimeters of window glass which cut off at about 310 millimicrons, thirty *Aëdes* were

exposed for forty-five minutes. All were living after twenty-four hours, and eighteen of the thirty fed on a guinea pig. Five were dead at the end of forty-eight hours. No others died until after one hundred fourteen hours when twenty-four of the thirty were living and at the end of one hundred sixty-eight hours twenty-three were living.

Thirty *Aëdes* were exposed for fifteen minutes with the light filtered through 4 millimeters of quartz and 1 centimeter of water. After twenty-four hours, twenty-seven were living and nineteen fed on a guinea pig. No more died until the end of one hundred twenty hours, when a total of four were dead. None died between one hundred twenty and one hundred forty-four hours.

TABLE 2.—*Mosquitoes exposed to ultra-violet light.*

[Voltage 65 and current 3.5 amperes in all the following cases.]

Distance.	Time.	Filter.	Number exposed.	Living at end of—							
				15 minutes.	30 minutes.	24 hours.	48 hours.	72 hours.	96 hours.	144 hours.	168 hours.
cm.	*min.*										
40	15	0	34	------	------	------	------	34	------	------	------
25	30	0	25	23	16	------	------	------	------	------	------
18	60	4 mm quartz and 1 cm water.	34	------	------	25	1	------	------	------	------
18	45	4 mm quartz and 1 cm water.	30	------	------	2	0	------	------	------	------
18	30	4 mm quartz and 1 cm water.	25	------	------	14	3	1	0	------	------
18	45	4 mm quartz, 1 cm water, and 2.5 cm window glass.	30	------	------	30	25	------	------	24	23
18	14	4 mm quartz and 1 cm water.	30	------	------	27	------	------	------	26	------

From these experiments it was thought that the maximum dose of X-ray for mosquitoes was two erythema doses if the insects were to be able to feed on a volunteer after exposure

and that the maximum exposure to ultra-violet would be about fifteen minutes.

Four volunteers, A.V. 34–Immordino, A.V. 35–Hawley, A.V. 36–Cook, and A.V. 37–Small were admitted to screened cubicles in Sternberg General Hospital February 27, 1931, and submitted to an observation period of thirteen days, during which time they showed no evidence of illness. All were recent arrivals in the Philippine Islands and gave no history of dengue. At 8 a. m. on the fourteenth day four lots of proven infective mosquitoes were treated as follows:

Lot 1 consisted of forty-six mosquitoes. They were exposed for fifteen minutes to ultra-violet produced by a mercury arc lamp with 65 volts crossing the arc and showing a current of 3.5 amperes and with a distance of 40 centimeters from the front of the feeding cell, the light being filtered through a cell of 4 millimeters of quartz and 1 centimeter of water. This cell passed light from 185 to 1,400 millimicrons wave length. Most of the insects congregated at the back of the feeding cell during the exposure so that the distance was about 50 centimeters from the arc to where the majority of the insects congregated. Many of the insects fell to the bottom of the feeding cell during the exposure but ten minutes later all had apparently recovered. One hour later three had died, seventeen refused to feed, and twenty-six fed on A.V. 34–Immordino. Six days later this volunteer developed typical dengue as shown by the chart (fig. 1). Of this lot of mosquitoes sixteen survived for nine days.

Lot 2 consisted of forty-six infected *Aëdes* and were subjected to the same conditions as outlined in lot 1, except that a window-glass filter, passing light from 310 to 1,400 millimicrons wave length, was inserted between the source of ultra-violet and the insects. Exposure time was fifteen minutes and distance 40 centimeters. One hour later two were dead, eighteen refused to feed, and twenty-six fed on A.V 36–Cook. Five days later this volunteer developed dengue as shown by the chart (fig. 2). Twenty-seven of these insects survived for nine days.

Lot 3 consisted of forty-six infected *Aëdes* that were treated as follows: An X-ray machine was set at 70 K.V., 5 M.A. and with a distance of 30 centimeters. The insects were radiated for six minutes with this setting, which exposed them to approximately one erythema dose. One hour later seven were dead, fifteen refused to feed, and twenty-four fed on A.V. 35–Hawley,

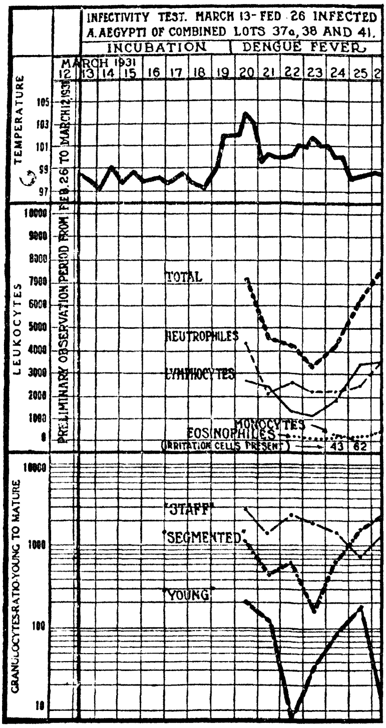

FIG. 1. Chart of American volunteer 34–Immordino.

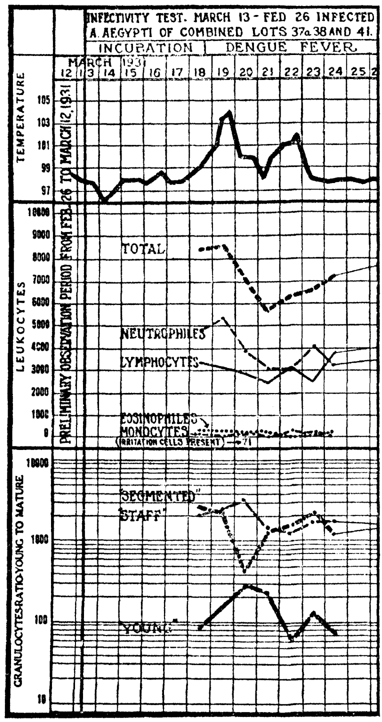

FIG. 2. Chart of American volunteer 36–Cook.

who developed dengue six days later, as shown by the chart (fig. 3). Seven mosquitoes survived nine days.

Lot 4 consisted of forty-two infected *Aëdes* that were subjected to X-ray radiation equal to approximately two erythema doses, the setting of the machine being the same as for lot 3 and the time doubled. At the end of one hour six were dead, seven refused to feed, and twenty-nine fed on A.V. 37–Small, who developed dengue on the sixth day, as shown in the chart (fig. 4). Only one mosquito survived nine days.

The insects showed great perturbation while being treated with X-ray and ultra-violet unscreened, but were not visibly disturbed by treatment with ultra-violet when a window-glass screen was interposed.

The disease produced in the above-mentioned volunteers was not modified insofar as we could determine.

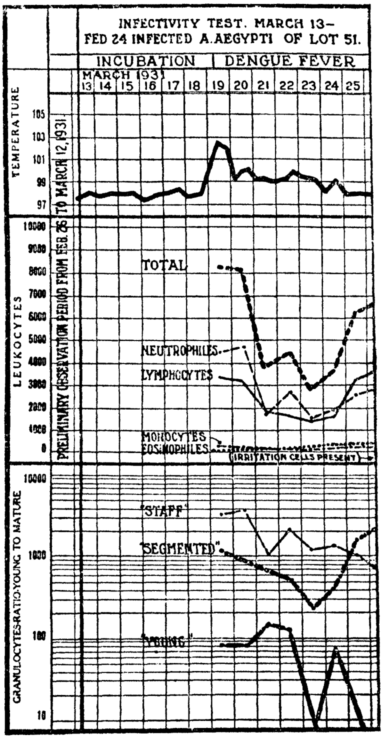

FIG. 3. Chart of American volunteer 35–Hawley.

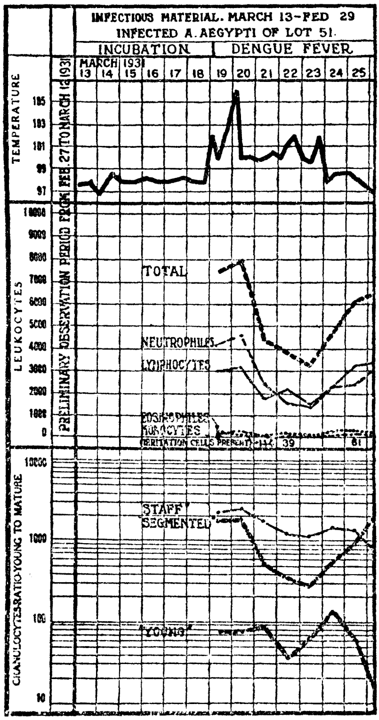

FIG. 4. Chart of American volunteer 37–Small.

CONCLUSIONS

Aëdes ægypti shows much greater resistance to the effects of ultra-violet light and X-ray than does man.

Dengue virus does not appear to be adversely affected by relatively large amounts of X-ray and ultra-violet, despite the fact that it is well known that several species of bacteria and molds are affected by ultra-violet light and that several of the fungi and their spores are affected by X-ray.

It seems apparent that no good can be hoped for in the treatment of dengue cases by the use of either of the above-mentioned forms of energy.

ILLUSTRATIONS

TEXT FIGURES

THE ATTEMPTED CULTIVATION OF MYCOBACTERIUM LEPRÆ

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ONE PLATE

The immediate activator of the present studies was the reported cultivation of *Mycobacterium lepræ* in 1929 by Wherry [1] in Manila and by Shiga[2] in Chosen, Korea.

In Wherry's studies, made in the School of Hygiene and Public Health in Manila, he reported microscopic proliferation of *M. lepræ* in cultures from three cases. One loopful of blood, obtained by the routine "snip" method, was inoculated into the water of syneresis of slants of glycerinized ovomucoid yolk agar, to which had been added 1 to 2 drops of autoclaved oleic acid and 1 to 2 drops of autoclaved 10 per cent dextrose solution in distilled water. Wherry reports that the best growth was obtained in cultures that were kept for a month at 35 to 37° C. at partial oxygen tension (diminished O_2 and increased CO_2), a condition that was brought about by attaching the culture tubes by means of rubber tubing to agar slants inoculated with *B. coli.* After one month at partial oxygen tension, a fine syringe needle was inserted through the connecting rubber tubing and the point of the needle buried in the cotton plug of

[1] Journ. Inf. Dis. 46 (1930) 263.
[2] Journ. Chosen Med. Assoc. 19 (1929) 1.

the culture tube, thereby establishing an O_2 and CO_2 environment.

Shiga used, as the source of his inoculum, excised leprous nodules that were ground in a 5 per cent solution of sulphuric acid. The suspension was next incubated for twenty minutes, and then centrifuged; the sediment was used for inoculation. The medium employed by Shiga consisted of 4 per cent glycerin bouillon potato wedges placed in Roux test tubes (reaction p_H 6.8 to 7.0) with the lower portion of the tube, below the constriction, filled with 4 per cent glycerin bouillon. Shiga reported growth of *M. lepræ* after two months of aërobic incubation at 37° C., but says: "Die Kolonien auf Kartoffeln sind zart, dünn und unsichtbar." However, he says that upon transplant to glycerin agar small, but visible, colonies developed.

The total number of cases cultured by us was twelve; all were active, recently admitted cases of leprosy at San Lazaro Hospital, Manila, that had received no treatment, with the exception of cases 11 and 12. We wish here to record our appreciation of the fine spirit of coöperation manifested by Doctor Velasco in placing these cases at our disposal. In the appendix will be found a brief description of each case, and the direct smear findings.

In all of the cases, the method of obtaining culture material was the same. The skin over the leprous lesion was treated with iodine, followed by alcohol; then the area to be incised was grasped with sterile forceps, and the incision made with a sharp sterile knife. Next, the interior was scraped with the tip of a second sterile knife, and blood containing lepra bacilli was obtained on the edge of the knife. In many instances, pieces of tissue were also obtained. By means of a sterile platinum loop a loopful of blood or a piece of tissue was transferred immediately to the water of syneresis in the culture tube; inoculations on the surface of the slant, just above the water of syneresis, were made as well. In each case, direct smears were made from blood or tissue scrapings approximately equal in amount to that employed as the inoculum of a single culture tube. Direct smears, as well as smears from cultures, were stained with steaming, and with unwarmed, carbol-fuchsin, followed by acid alcohol and a counter stain of dilute Löffler's methylene blue.

The media employed in our cultural studies were as follows: (1) 4 per cent, 5 per cent, and 6 per cent glycerin ovomucoid yolk agar containing oleic acid and dextrose (Wherry medium);

(2) 4 per cent glycerin bouillon Irish potato wedges (Shiga medium); (3) 4 per cent glycerin bouillon lakatan (banana) wedges; (4) 4 per cent glycerin bouillon saba (banana) wedges; (5) 4 per cent glycerin bouillon sweet potato wedges; (6) 4 per cent glycerin bouillon gabi (tuber) wedges; (7) 4 per cent glycerin bouillon ubi (tuber) wedges; (8) lakatan agar slants (p_H 7.2), made by mixing one part of ground 4 per cent glycerin lakatan with two parts of 2.5 per cent meat infusion agar; (9) serum glucose cystine agar slants and columns (Francis),[3] to which in certain series 1 drop of normal human serum was added to the water of syneresis, and to others 1 drop of syphilitic serum; and (10) infant human brain agar slants, made by mixing one part of ground 4 per cent glycerin brain with one part of 3 per cent nutrient agar, plus 2 drops of 10 per cent dextrose solution and 2 drops of nucleic acid to each 3 cubic centimeters of medium. In addition, slants of plain glycerin and blood agar, as well as of Löffler's blood serum, were employed as controls.

All of our cultures, primary cultures as well as transplants, were incubated continuously at 37° C. for periods ranging from eleven weeks to seven months, with the exception of one series that was kept at room temperature. In all instances, parallel culture tubes were incubated (*a*) aërobically, uncapped and covered with a rubber cap; (*b*) anaërobically, by means of pyrogallic acid and potassium hydroxide; (*c*) partial oxygen tension and increased CO_2. In certain of the partial oxygen tension series, the original *B. subtilis* or *B. coli* was allowed to remain unchanged during the entire period of incubation; in others, freshly inoculated slants were attached to the culture tubes every twenty-four hours. In other series, after four to six weeks incubation under diminished oxygen and increased CO_2, oxygen was admitted by inserting a fine needle through the connecting rubber tubing, and burying the point in the cotton stopper of the culture tube.

A detailed analysis of the cultural findings in each case that we studied will not be attempted. Rather, we will endeavor briefly to review our results as a whole, with illustrative references to certain typical cases.

Aërobic cultures, both capped and uncapped, have shown a shorter persistence of *M. lepræ,* in smaller numbers, than have

[3] Public Health Reports **38** (1923) 1396.

the comparable partial tension and anaërobic cultures. Aërobic cultures on glycerin bouillon lakatan wedges, glycerin bouillon saba, glycerin bouillon sweet potato, glycerin bouillon gabi, glycerin bouillon ubi, lakatan agar slants, serum glucose cystine agar slants, as well as slants of plain glycerin and blood agar and Löffler's blood serum, have revealed a quite regular disappearance of the implanted acid fasts within two weeks of incubation at 37° C., and in a shorter time at room temperature. There is a relatively brief persistence of the microörganisms with typical staining reaction, followed by a rather rapid loss of acid-fastness, and then by autolysis. Somewhat irregular persistence of *M. lepræ* for a longer period of time was observed in certain cases in aërobic 37° C. cultures on infant human brain agar, glycerin ovomucoid yolk agar (Wherry medium), and glycerin bouillon Irish potato wedges; in cases 1, 4, 5, 6, 7, 8, 9, and 10, the original aërobic cultures revealed no acid fasts after one month at 37° C. In case 2 (Claudio Quinto), in which direct smears from the lesion showed enormous numbers of *M. lepræ,* a smear from a fragment of blood and tissue scraping planted on an aërobic slant of infant human brain agar revealed brightly staining, typical acid fasts in pure culture at the end of forty-eight days' incubation at 37° C. The acid fasts were not, however, in as large numbers as in the comparable partial tension culture, and they disappeared on longer incubation. In the same case 2, a comparable smear from the same amount of inoculum on aërobic glycerin bouillon Irish potato showed somewhat smaller numbers of equally typical acid fasts in pure culture upon forty-three days' incubation at 37° C., which disappeared on further incubation; whereas a comparable smear from the same amount of inoculum in the water of syneresis and on the surface of a slant of glycerin ovomucoid yolk agar (Wherry medium) revealed no acid fasts at the end of forty-three days' incubation at 37° C. On the other hand, in case 3 (Pablo Carpio), which likewise showed *M. lepræ* in enormous numbers in direct smears from the lesion, a smear from the glycerin bouillon Irish potato incubated for forty-three days at 37° C. showed a few scattered, rather poorly staining, partially autolyzed acid fasts in pure culture, whereas a comparable smear from the same amount of inoculum in a slant of glycerin ovomucoid yolk agar incubated for the same time at 37° C., showed somewhat larger numbers of brightly staining, typical acid fasts in pure culture, which disappeared upon longer incubation. Continuous incubation at 37°

C. for five to seven months of all of our original aërobic cultures has not alone failed to reveal any evidence of multiplication of the implanted *M. lepræ,* but in the extremest instances of persistence of the microörganisms in aërobic cultures no acid fasts were found after two months' incubation. Aërobic transplants to the same medium, as well as to all other media employed in our studies, made at weekly intervals and at the end of four and six weeks' continuous incubation, from all original aërobic cultures that showed a persistence of *M. lepræ* in pure culture, have consistently failed to reveal any evidence of multiplication of the transferred *M. lepræ.* Moreover, in aërobic transplants, the numbers of *M. lepræ* have consistently diminished, and in second and third transplants the acid fasts have entirely disappeared.

In all of the twelve cases studied, partial oxygen tension cultures revealed a longer persistence of *M. lepræ,* in larger numbers, and with more typical morphological and staining characters, than did the corresponding aërobic cultures. Usually, cultures made anaërobic with pyrogallic acid and potassium hydroxide yielded a longer persistence of *M. lepræ* in larger numbers, in larger clumps and more vividly acid fast, than did the corresponding partial oxygen tension cultures; in partial tension cultures, *M. lepræ* appeared somewhat shorter than in anaërobic cultures. Acid fasts, both granular and solid forms, were quite regularly found in the largest numbers if smears were made from a fragment of blood or tissue implanted in the water of syneresis, or on the surface of the medium just above the water of syneresis. However, in no instance in any of our partial tension and anaërobic cultures, originals as well as in transplants, was observed any evidence of microscopic, or undisputable microscopic, multiplication of *M. lepræ.* As in the aërobic series, continuous incubation was employed at 37° C. and at room temperature for periods ranging from five to seven months. In both the partial tension and in the anaërobic series, the best and longest persistence of *M. lepræ* was obtained on glycerin ovomucoid yolk agar, glycerin bouillon saba wedges, infant brain agar, and in one instance 4 per cent glycerin chicken bouillon sweet potato, at 37° C. In certain of the original anaërobic and partial tension cultures on these media *M. lepræ* have been found in large numbers in pure culture after ninety-six days of continuous incubation, the extreme instance being one hundred fifty-eight days. First transplants have revealed

still considerable, but smaller, numbers of *M. lepræ* in pure culture after twenty-four to ninety-six days incubation; and second transplants have showed a persistence of still smaller numbers of *M. lepræ* in pure culture for shorter periods of time, ranging from twenty-four to thirty-six days. Aërobic transplants from partial oxygen tension and anaërobic original cultures revealed a persistence of *M. lepræ* in decreasing numbers for a few weeks, with diminished acid-fastness, and their complete disappearance within one month or less. On the other hand, partial oxygen tension transplants from original partial oxygen tension cultures, anaërobic transplants from anaërobic original cultures, as well as partial oxygen tension transplants from anaërobic cultures and anaërobic transplants from partial oxygen tension cultures, all revealed a longer persistence, in larger numbers, of more typical and more brightly acid-fast bacilli.

In the case of our partial oxygen tension series of cultures, originals as well as transplants, no demonstrable difference in the persistence of *M. lepræ,* nor in its numbers, was noted in cultures incubated continuously with the same original tube of *B. subtilis* or *B. coli* attached, and in those to which fresh tubes of *B. subtilis* or *B. coli* were attached daily. Again, no significant difference was observed in the persistence of *M. lepræ* when transplants were made from original cultures at weekly intervals, at the end of four to six weeks' continuous incubation, and after two to four months of continuous incubation. However, the longest persistence of *M. lepræ* in large numbers was observed by us in an original partial tension culture made from case 9. This culture, made by planting a loopful of bloody scrapings on the surface of a 4 per cent glycerin chicken bouillon sweet potato wedge just above the glycerin, was incubated continuously at 37° C. for eighty-eight days at partial oxygen tension, with the original slant of *B. coli* attached. At the end of this period, oxygen was admitted to the culture, according to the method suggested by Wherry,[4] by inserting a needle through the connecting rubber tubing into the cotton plug of the culture tube. The culture was then reincubated at 37° C. for another seventy days, making a total incubation period of one hundred fifty-eight days, at the end of which time the culture was examined. A smear made from a fragment of the dark brown inoculum revealed, on a five-minute search,

[4] Loc. cit.

twenty clumps of vividly acid fast, granular, *M. lepræ* in pure culture. The majority of the clumps consisted of from four to about thirty *M. lepræ,* with a few scattered groups of two to three members.

As illustrative of our anaërobic results, we might cite certain of our cultural findings on case 6. At the time of making the original cultures from this case, direct smears revealed *M. lepræ* in relatively small numbers, an average of about ten acid fast bacilli per oil-immersion field; the majority were in small clumps of six to eight members. A platinum loopful of bloody scrapings from the incised lesion was immediately planted on the surface of a glycerin bouillon saba wedge, just above the glycerin, and the culture was made anaërobic with pyrogallic acid and potassium hydroxide. At the end of twenty-six days continuous incubation at 37° C., the tube was opened and a smear was made from a small fragment of the implanted bloody scraping. This smear revealed in pure culture, quite large numbers of typical *M. lepræ,* granular and solid forms, averaging from thirty to forty per oil-immersion field; the majority of the acid fasts were in clumps of from fifteen to about one hundred members. In as much as the direct smear from the lesion had shown only about ten *M. lepræ* per oil-immersion field, the majority in small clumps of six to eight members, these cultural findings seemed somewhat encouraging. They might be interpreted as suggesting that the implanted *M. lepræ* had undergone a certain amount of preliminary multiplication; again, the results might be explained by assuming that the loopful of inoculum used for this particular culture tube contained a larger number of *M. lepræ* than did the material used for making the direct smear. Which of the two interpretations is the correct one, we do not know; it seems to us, however, that the second alternative is at least equally as valid as the first. At any rate, the subsequent history of this original culture would indicate that if a certain initial proliferation of *M. lepræ* did occur, this mulplication was not sustained. On examination of the culture at the end of fifty days continuous anaërobic incubation at 37° C., a smear made from approximately the same-sized fragment of implanted blood scraping revealed acid fasts in smaller numbers, averaging from eight to ten per oil-immersion field, and after ninety-six days of continuous anaërobic incubation, no *M. lepræ* were found. Analogous anaërobic and partial oxygen tension cultures made on 6 per cent glycerin ovomucoid yolk agar and on glycerin Irish potato wedges at

the same time as the original anaërobic saba wedge culture was made, revealed only a few scattered acid fasts after twenty-six days at 37° C., and at the end of fifty days' incubation no *M. lepræ* were found.

An anaërobic glycerin bouillon saba wedge transplant 1, was made from the original anaërobic saba culture at the end of twenty-six days' incubation at 37° C., an amount of inoculum being employed that was approximately the same as in making the smear. After forty-nine days at 37° C., this transplant 1 revealed in pure culture an average of about ten *M. lepræ* per oil-immersion field. The majority of the acid fasts were of the granular type, but scattered, longer, thinner, solid forms occurred; clumps of from twenty to fifty plus brightly staining acid fasts were found. Anaërobic transplant 2 on glycerin bouillon saba, made from anaërobic saba transplant 1 at the end of forty-nine days at 37° C., revealed on eleven days' incubation at 37° C. only one granular acid fast; on twenty-five day's incubation, as well as at the end of three months, no *M. lepræ* were found.

Anaërobic transplant 1 to a glycerin Irish potato wedge, made from the original glycerin bouillon saba wedge after twenty-six days of anaërobic incubation, revealed only a few, scattered, feebly acid fast *M. lepræ* in pure culture after forty-nine days' incubation at 37° C., and by the end of ninety-five days' incubation no acid fasts could be found. Anaërobic transplant 1 to the water of syneresis of a 6 per cent glycerin ovomucoid yolk agar slant, made from the original anaërobic glycerin bouillon saba culture after twenty-six days of incubation, revealed no acid fasts at the end of forty-nine, sixty-three, and ninety days' incubation. Partial oxygen tension transplant 1 on glycerin Irish potato, glycerin bouillon saba wedges, and into the water of syneresis of glycerin ovomucoid yolk agar slants, made from the original anaërobic glycerin bouillon saba culture after it had been incubated twenty-six days, revealed a few scattered *M. lepræ* in pure culture after forty-nine days at 37° C., but on later examinations no acid fasts could be found.

SUMMARY

The longest persistence of *M. lepræ* in pure culture, and in large numbers, that was observed by us was one hundred fifty-eight days. This occurred in an original partial oxygen tension culture from case 9 on 4 per cent glycerin chicken bouillon sweet

potato, incubated at 37° C. for eighty-eight days, with the original tube of *B. coli* attached. At the end of this time, oxygen was admitted according to the method suggested by Wherry,[5] and the culture was reincubated for another seventy days.

In the remaining eleven cases, somewhat longer persistence in pure culture of larger numbers of somewhat more typical appearing *M. lepræ* was obtained at 37° C. under anaërobic conditions (pyrogallic acid and potassium hydroxide) than at partial oxygen tension. Of the media employed by us, the most favorable were glycerinized ovomucoid yolk agar slants (Wherry medium), glycerin bouillon saba wedges, and infant brain agar slants. In certain of such anaërobic cultures, *M. lepræ* have been found in pure culture, and in large numbers, after ninety-six days of continuous incubation at 37° C.

The next best persistence of *M. lepræ* in pure culture was obtained in partial oxygen cultures on the same media at 37° C. In certain of such cultures, *M. lepræ* have been found in large numbers after ninety-six days' continuous incubation, and in one case after one hundred fifty-eight days. No demonstrable difference was observed in cultures to which a fresh tube of *B. coli* or *B. subtilis* was attached every twenty-four hours, and in cultures to which the original tube of *B. coli* was allowed to remain attached during the entire period of incubation.

The shortest persistence of *M. lepræ*, in the smallest numbers, was obtained in our aërobic cultures, in which an irregular persistence of *M. lepræ* for from fourteen to forty-three days was observed.

First, second, and third transplants, aërobic, partial oxygen tension and anaërobic, have shown a progressive diminution in the number of *M. lepræ*, with a disappearance of acid fasts in the third transplants. No demonstrable difference in the persistence of *M. lepræ* was observed when transplants were made at weekly intervals, at intervals of three to six weeks, and at intervals of two to three months.

The addition of cystine in 0.1 per cent concentration, of normal human serum, and of syphilitic serum appears to exert no favoring action upon the persistence of *M. lepræ* in cultures.

In none of our original cultures and transplants, which were incubated at 37° C. for periods ranging from four to seven months, did we obtain any macroscopic evidence of multiplica-

[5] Loc. cit.

tion of the implanted *M. lepræ,* nor did we obtain any indisputable microscopic evidence of proliferation.

APPENDIX; DESCRIPTIONS OF CASES

Case 1—Vicente Arriola.

Age 32. Male. Single. Filipino. Occupation, fireman. Family history for leprosy negative. First sign and symptom, anæsthesia on left knee six months ago. Never received antileprotic treatment. Physical condition good. Local lesions are numerous, small, pale pinkish, slightly elevated macular patches all over trunk, buttocks, upper extremities, thighs, the left and lower portion of the face. No nodules. Slight infiltrations in face, ear lobes, and left knee.

Summary.—A case of moderate cutaneous, slight neural leprosy of six months' duration. Cultures made from left malar eminence.

Direct smear.—*M. lepræ* in small packets and singly; bacilli average about 15 in number per oil-immersion field and are bright staining.

Case 2—Claudio Quinto.

Age 40. Male. Married. Filipino. Occupation, quarryman. Family history for leprosy negative. First sign and symptom, anæsthesia on both legs, preceded by nodules, five years ago. Never received antileprotic treatment. Physical condition fair. Local lesions are dry, wrinkled, macular patches on trunk and thigh; extensive infiltrations on ears and face, less extensive on trunk, buttocks, and extremities. Indurated, thickened skin on legs and feet. Anæsthesia extensive on both extremities.

Summary.—A case of advanced cutaneous and advanced neural leprosy of five years' duration. Cultures made from right ear.

Direct smear.—Enormous numbers of bright-staining *M. lepræ,* the majority in large or small masses, but with many single acid-fast rods. The number of bacilli averages over 100 per oil-immersion field.

Case 3—Pablo Carpio.

Age 19. Male. Single. Filipino. No occupation. Family history for leprosy negative. First sign and symptom, anæsthesia on forearm and right elbow, six years ago. Never received antileprotic treatment. Physical condition fair. Local lesions are extensive; infiltrations on ear, face, nipples, hands, and feet; no macules. Beginning nodular pigmentation and tænia of the ear, medial aspect of palm, forehead, and feet; indurated, thickened skin on legs.

Summary.—Advanced cutaneous and advanced nodular leprosy of six years' duration. Cultures made from right ear and forearm.

Direct smear.—Enormous numbers of bright-staining *M. lepræ,* the majority in large or small masses, but with many single acid-fast rods. Bacilli average over 150 per oil-immersion field.

Case 4—Juana Falcone.

Age 36. Female. Single. Filipino. No occupation. Family history for leprosy negative. First sign and sympton was a slight numbness over right leg one year ago. Never received antileprotic treatment. Physical condition poor. Local lesions are macules, numerous on back, anterior chest wall, and epigastrium. Infiltration diffuse on face, ears, fingers,

and toes. Nodules, large and small, on elbows, forearms, buttocks, arms, and lower extremities. Maculopapular areas on lower and upper extremities.

Summary.—Advanced cutaneous and slight neural leprosy of one year's duration. Cultures made from right ear lobe.

Direct smear.—Relatively small numbers of brightly staining *M. lepræ*, practically all single. Becilli average about 5 per oil-immersion field.

Case 5—Gregorio Jabines.

Age 44. Male. Widower. Filipino. Occupation, merchant. Family history for leprosy negative. First sign and symptom was one, large reddish macule on abdominal wall two years ago. Never received antileprotic treatment. Condition fair. Local lesions are macules on face, ears, chest, abdomen, back, lower and upper extremities, and nape of neck. Nodule on ear; no infiltrations.

Summary.—Moderate advanced macular leprosy of two years' duration. Cultures made from arm.

Direct smear—M. lepræ in moderately large numbers averaging about 30 per oil-immersion field. Majority of bacilli are single, with occasional small masses of four to eight members. *M. lepræ* stains more feebly than in cases 1 and 4.

Case 6—Rosa Musni.

Age 14. Female. Single. Filipino. No occupation. Family history for leprosy negative. First sign and symptom was anæsthesia of forearm one year ago. Never received antileprotic treatment. Condition good. Local lesions are macules on cheeks, ears, chest, abdomen, and right forearm. Infiltrations on ear. No nodules. Ichthyosis, both legs.

Summary.—Moderate cutaneous and slight neural leprosy of one year's duration. Cultures made from left ear.

Direct smear.—M. lepræ in relatively small numbers, averaging about 10 per oil-immersion field. Majority are in small masses of six to eight members. *M. lepræ* stains slightly more brightly than in case 5.

Case 7—Laynes.

Age 18. Male. Single. Filipino. Occupation, laborer. Family history for leprosy negative. First sign and symptom was redness of face and thickening of nose and ears three months ago. Never received antileprotic treatment. Condition fair. Local lesions are macules, big and depigmented, on trunk, arms, and thighs. Infiltration extensive on face and ear. No nodules.

Summary.—Macular, moderately advanced cutaneous, and slight neural leprosy, of three months' duration. Cultures made from left ear.

Direct smear.—M. lepræ in moderate numbers, averaging about 35 per oil-immersion field. Majority are in masses of fifteen to twenty-five members; bacilli stain brightly.

Case 8—Yep Heng.

Age 25. Male. Single. Chinese. Occupation, carpenter. Family history for leprosy negative. First sign and symptom were reddish, anæsthetic patches on internal aspect of right knee about one and a half years ago. Never received antileprotic treatment. Condition good. Local le-

sions are macules on face, ears, chest, abdomen, back, nape of neck, and upper extremities. No infiltration; no nodules.

Summary.—Moderate macular leprosy of about one-half year's duration. Cultures made from cheek.

Direct smear.—*M. lepræ* in relatively small numbers, averaging about 15 per oil-immersion field. Single acid fasts predominate, with occasional clumps of eight to ten members. *M. lepræ* stains rather feebly.

Case 9—Leopoldo Duque.

Age 16. Male. Single. Filipino. Occupation, farmer. Family history for leprosy reveals a leprous father. First sign and symptom were whitish areas on right knee about one year ago, after recovery from measles; also large areas of same character on abdomen. Never received antileprotic treatment. Condition fair. Local lesions are macules on cheeks, abdomen, back, lumbar region, right arm, and anterior aspect of thighs. Infiltrations in alæ nasæ and cheeks. No nodules. Ulnar and common perineal nerves thickened.

Summary.—Moderate macular and moderate neural leprosy of about one year's duration. Cultures made from ear.

Direct smear.—*M. lepræ* in relatively small numbers, averaging about twelve per oil-immersion field. Majority of bacilli are single, with occasional clumps of eight to twenty members. *M. lepræ* stains brightly.

Case 10—Feliciano Duque.

Age 42. Male. Married. Filipino. Occupation, farmer. Family history for leprosy reveals a leprous brother-in-law. First sign and symptom were numbness over both feet about fourteen months ago. Never received antileprotic treatment. Condition fair. Local lesions are macules on cheeks, chest, abdomen, back, lumbar region, both arms, buttocks, and anterior aspect of thighs. Infiltrations on both ears and cheeks. No nodules. Ulnar, great auricular, and common perineal nerves thickened.

Summary.—Moderate macular and moderate neural leprosy of about fourteen months' duration. Cultures made from ear.

Direct smear.—*M. lepræ* in small numbers, averaging about two per oil-immersion field. Majority are single, with very occasional clumps of four to eight members. Bacilli stain brightly.

Case 11—Jose Cabie.

Age 17. Male. Single. Filipino. Occupation, farmer. Family history for leprosy reveals a leprous mother and brother. First sign and symptom were redness on cheek and thickening of ears ten years ago. Received antileprotic treatment, and several injections, several years ago. Physical condition good. Local lesions are extensive macules and nodules over face, ears, arms, and entire body, with ulcerations on legs. Slight enlargement of ulnar nerve. Atrophy of digits.

Summary.—Moderately advanced cutaneous and advanced neural leprosy of ten years' duration. Cultures made from ear, with tissue and blood scrapings.

Direct smear.—*M. lepræ* in moderate numbers, averaging about twenty per oil-immersion field. Majority are in loose or tight clumps of twenty-five to fifty members. Acid fasts stain brightly.

Case 12—Valeriano Cabie.

Age 18. Male. Single. Filipino. Occupation, farmer. Family history for leprosy reveals a leprous mother and brother. First sign and symptom were reddish areas on face and body twelve years ago. Received antileprotic treatment for one month three months ago. Physical condition good. Local lesions are extensive; macules and nodules over face, ears, arms, and entire body, with ulcers on legs.

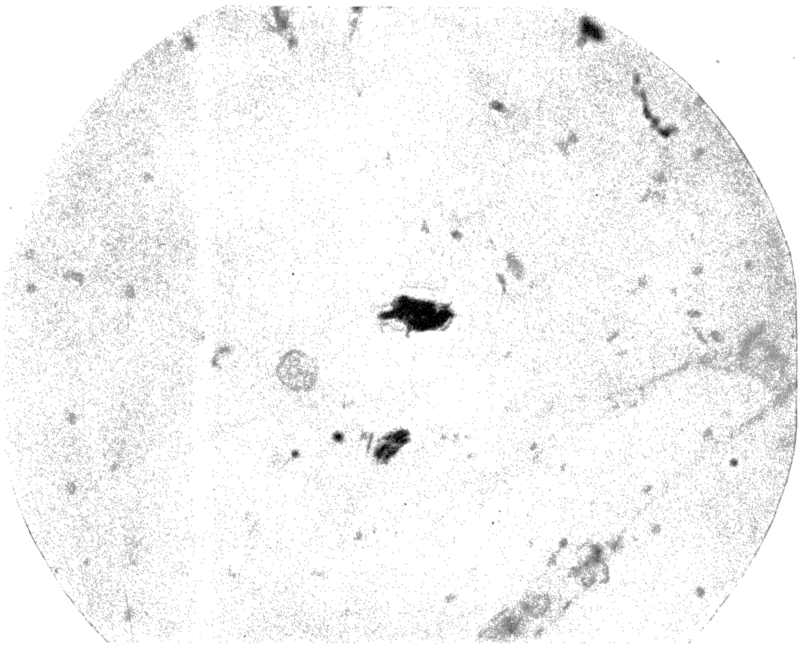
Summary.—Advanced cutaneous and neural leprosy of twelve years' duration. Cultures made from ear, with tissue and blood scrapings.

Direct smear.—*M. lepræ* in very large numbers, averaging about one hundred per oil-immersion field. Majority are single, but there are many loose clumps of eight to sixteen members, and tight clumps of twenty to fifty members. Acid fasts stain brightly.

ILLUSTRATION

PLATE 1

FIGS. 1 and 2. Smear from a 158-day growth of *Mycobacterium lepræ.*



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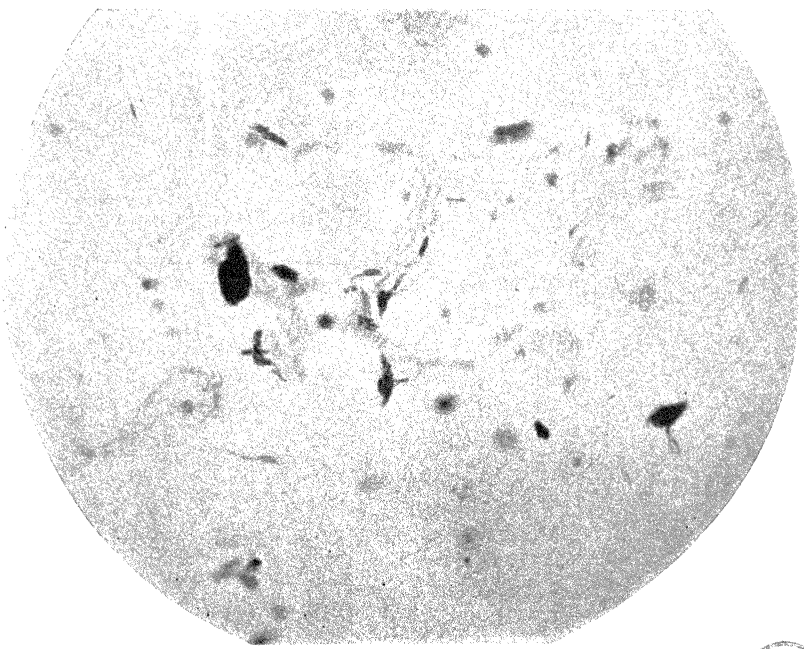

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PLATE 1.

SOMATIC SEGREGATION IN DOUBLE HIBISCUS AND ITS INHERITANCE [1]

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THREE PLATES AND ONE TEXT FIGURE

INTRODUCTION

The study of somatic segregation is important genetically for at least two reasons. One reason is that many horticultural varieties of plants have their origin in that type of somatic segregation which is called bud mutation. A second reason is that a somatic segregation may or may not be sexually heritable; hence offering no little difficulty to a geneticist who is studying the inheritance in crosses in which one of the parents or the two used arises as bud sports. An example may help in explaining this point. I have in my plant collection a variety of cassava (*Manihot utilissima* Pohl) which is highly ornamental because the area comprising the center and base of the lobes of its leaf is yellow when the leaf is young and white when it is old. This variety came from a bud sport of another cassava which like most plants of *Manihot utilissima* has solid-green leaves. I have grown about a hundred seedlings of this ornamental cassava and every one of them has solid-green leaves. Knowing its vegetative origin it is of course easy to understand why the ornamental character is not heritable sexually. But let us suppose that we did not know its origin and that this ornamental variety had been crossed for purposes of Mendelian study with a variety with solid-green leaves. The results of such a cross would be highly confusing for we would be looking in the F_2 offspring for a character which would not be there. A confusion arising in this way might be avoided by a study of selfed seedlings of the parents used in crossing, but this is only possible

[1] Experiment Station contribution No. 750. Read before the Los Baños Biological Club February 26, 1931. Received for publication June 17, 1931.

in case of varieties that are self-fertile and self-compatible. If they happen to be self-sterile and self-incompatible then only a knowledge of their vegetative parentage could aid a geneticist in explaining the confusing results obtained in hybridization work involving such somatic segregation.

OBJECT OF THE PRESENT WORK

The object of this paper is to report three types of somatic segregation that have occurred in "double" varieties of *Hibiscus rosa-sinensis* Linnæus and the results of crosses made involving flowers from these somatic segregates.

REVIEW OF LITERATURE

As early as 1913 Wilcox and Holt (1913) reported somatic segregation in flowers of double hibiscus. They reported that "on the Double Salmon there are occasionally dark red double flowers, and the Double Yellow now and then bears a regular double flower half yellow and half salmon, or occasionally flowers which are of salmon color throughout."

The first published report on somatic segregation in *Hibiscus* in the Philippines was made by Mendiola and Capinpin in 1923. They then reported a case of a bud sport consisting of a branch of a pink variety of *H. rosa-sinensis* producing white flowers; and another case of a branch of a red variety producing pink flowers. They also reported cases of plants with entire leaves producing lobed leaves usually at the base of the plant. This case of dimorphism was subsequently studied by the senior author and in a paper published in 1926 he reported that such presence or absence of lobing in the leaves occurred at the juvenile stage of a plant arising either as a seedling or as a cutting and that the presence of lobes in juvenile leaves of *Hibiscus rosa-sinensis* is a simple dominant over absence of lobes.

While I was in Java in 1927, I received a letter from Dr. Jean Schweizer, botanist of the Besoekishch Experiment Station in that country, calling my attention to the occurrence in his garden of a bud variation in *Hibiscus* consisting of a simple red flower which had been produced by a plant of the Double Salmon variety. Doctor Schweizer described the simple flower as in no way different from the common hedge *Hibiscus*. By the common hedge *Hibiscus* I refer to the variety that is common in the Philippines, which I have been calling Native Red Single.

TIME AND PLACE OF THE WORK

The work here reported which covered a period of more than one year, was started December 30, 1929, and the experiments were performed both in the author's plant-breeding garden and in the plant-breeding nursery of the College of Agriculture, Los Baños, Laguna.

OBSERVATIONS AND EXPERIMENTS

CASES OF VEGETATIVE SEGREGATION OBSERVED

A periclinal chimera in a flower of the Double Salmon.—A case was found in which a Double Salmon plant produced a flower which was similar to that of a Double Red except that a number of the petals in the center of the flower remained salmon in color. This would appear to be a case of a periclinal chimera and suggests that the Double Red might have originated as a bud sport of the Double Salmon. The flower showing the chimera was not used in any pollination work as it was severed from the plant when it was given to the author by Professor Herbert, formerly of our Plant Physiology Department.

A bud sport consisting of Double Carmine produced by Double Rose.—If one examines a flower of a Double Rose hibiscus he finds that its "eye" is carmine in color. It apears that through some somatic change during the early history of a bud, a branch can arise which produces flowers all carmine in color instead of being rose with a carmine eye. Such a branch has been produced, and by its propagation by cuttings it has made possible the existence of the variety which we call Double Carmine.

It is quite possible that the first case is a manifestation of the same phenomenon as the second except that in the former, for some reason, the segregation was not completed.

Simple flowers from double varieties.—The production of a simple flower by a double variety has been observed on one branch of a plant of the Double Carmine (see Plate 1) and four branches of a plant of the Double Rose. Two simple flowers were produced by the Double Carmine plant; one was produced December 30, 1929, and the other January 5, 1930. One branch of the Double Rose produced one single flower, in August, 1930. Two other branches, January 29, 1931, produced simple flowers. One of these branches produced one simple flower, and the other branch produced one simple flower and one flower with two whorls of five petals each. These three flowers were excep-

FIG. 1. A periclinal chimera shown by a flower of the Double Salmon hibiscus.

tionally large, measuring 17 centimeters across with pistil about 9 centimeters long. The simple flowers produced by the double varieties were used in pollination experiments which are described later in this paper. For convenience, the simple flowers from Double Carmine are henceforth called Mutant Simple Carmine and those from Double Rose, Mutant Simple Rose.

EXPERIMENTS

Self-pollination.—The two single flowers produced by the Double Carmine were self-pollinated the days they were produced to determine if they were self-compatible and to find out if and how simpleness occurring as a bud segregation in a double variety as well as the carmine color arising from a rose variety with carmine eye were heritable. The same thing was done with the two simple flowers and with the flower with two rows of petals produced by the Double Rose January 29, 1931.

Cross-pollination.—Besides self-pollinating the simple flowers produced by the Double Carmine, they were crossed with nine simple varieties using the former as the source of pollen. The amount of pollen, coming as it did from only two flowers, was quite limited and it was not possible to use as female more than

a total of eighteen flowers of the nine simple varieties mentioned.

The two single flowers produced by Double Rose January 29, 1931 were used as male and crossed with fifteen flowers of seven single varieties.

RESULTS OF EXPERIMENTS

Of self-pollination.—The simple flowers produced by the Double Carmine and the Double Rose failed to ripen pods upon self-pollination, suggesting the probability of self-incompatibility in this case of somatic segregation.

Of cross-pollination.—Of the nine different crosses made between the Mutant Simple Carmine and Single varieties, involving eighteen flowers on the female side, only one succeeded; namely, that with the variety 19–Pink 12396–104. The results of cross-pollination between the Mutant Simple Rose and other varieties are not reported in this work.

The hybrids obtained.—From the successful cross eight plants were obtained. They were given pedigree Nos. 5333, 5334, etc., up to 5340 (see Plate 2). Table 1 gives a brief description of the hybrids. Hybrid 5340 is shown in Plate 3, fig. 1, and hybrid 5333, in Plate 3, fig. 2. It will be noted in Table 1 that of the eight hybrids produced, four turned out to be double and four, single, suggesting a 1: 1 ratio and the heterozygosity of one of the parents. While no two of these eight hybrids are exactly alike and none of them is exactly like any other existing variety, most of them are not enough different to warrant their being considered novelties. However, the case is different with No. 5339, which has light French vermilion corollas. As there is no known vermilion double hibiscus, this hybrid, which we will now call Double Vermilion, constitutes an entirely new horticultural variety.

It may be of interest to note here certain habits of some of the hybrids. Let us take No. 5333. This hybrid has a habit which may be called telescopic production of two successive flowers on one peduncle. About ten days after a flower is produced normally on one flower stem, instead of the evidently empty pod falling off, another flower bud begins to come out of it. The bud develops and opens slowly for about twenty days, then it falls off—the flower never opens completely. The second flower is completely sterile, and the normal is fertile in both sexes. A plant with a similar habit was reported by Wilcox and Holt (1913).

TABLE 1.—*Description of hybrids between simple flowers of Double Carmine and a simple variety, 19–Pink 12396–104, and of the parents.*

	Double Carmine.	Simple flowers from Double Carmine.	19-Pink 12396–104.	Hybrid No.— 5333	Hybrid No.— 5334	Hybrid No.— 5335
Corolla	Multiple	Single	Single	Multiple	Single	Single.
Color of corolla	Carmine	Carmine	Yellow	Light French vermilion.	Yellow	Light vermilion.
Color of eye	Carmine	Carmine	No eye	Dark carmine.	No eye	Carmine.

	Hybrid No.— 5336	Hybrid No.— 5337	Hybrid No.— 5338	Hybrid No.— 5339	Hybrid No.— 5340
Corolla	Single	Multiple	Multiple	Single	Multiple.
Color of corolla	Light orange with vermilion veins.	Carmine	Carmine	Light French vermilion.	Rose.
Color of eye	Carmine	Dark carmine		Dark carmine	Carmine.

Hybrid 5338 produces flowers which either never open completely or open only after about two weeks from the time the petals begin to appear. As in the case of the telescopic flower of No. 5333 the flowers of No. 5338 stay on the stem for a long time. The persistence of the flower on the stem and the inability to open completely appear to be correlated in the case of these two hybrids. What significance this correlation may have as a general biological phenomenon arouses our curiosity.

DISCUSSION OF RESULTS

Because of the accidental nature of the somatic segregation reported and used in this work and the very limited number of flowers which could be used in the pollination experiments and the consequent small number of hybrids which could be obtained, the results presented in this paper necessarily do not have the reliability which more ample data possess. However, as the accident might not happen again for many years or might never happen again, it seems excusable to report these results at this time. Besides, limited though their source is, they nevertheless suggest a number of interesting biological conclusions.

Origin of doubleness and of double varieties.—The term doubleness when used to describe a flower refers to the number of its corollas, and means either two corollas or more than two. The corollas may be arranged as concentric whorls or each may occur with its own center and outside the other. Considering the kinds of vegetative segregation reported in this paper, it may be considered as certain that some of our double varieties are color segregates of other double kinds, while some of our simple varieties arose as bud sports of others which bear multiple corollas. It is interesting to note here that in the case of *Hibiscus syriacus* Linnæus the Double and Simple white varieties are similar in practically all respects, except that one produces double flowers and the other simple flowers. The same is true with the Double Lilac and Simple Lilac. Furthermore, the white varieties are similar to the lilac, except in color. All of these similarities suggest common vegetative parentage for all these four varieties of *H. syriacus*, sexual parentage being highly improbable as none of them is self-fertile.

When we attempt to explain the origin of doubleness in *Hibiscus* we find ourselves treading on more theoretical grounds. The habit already cited of hybrid 5333, of bearing two successive flowers on one flower stem seems to me to betray the secret of the origin of doubleness. Hybrid 5333 is a very prolific flower bearer. These two characteristics of No. 5333 suggest that doubleness has its origin in heterosis, or hybrid vigor. It is possible that natural crossing between two previously existing simple varieties produced hybrid vigor in the hybrid. The hybrid vigor resulted in the capacity of the hybrid to produce a much greater number of flowers than either one of its parents. Some of these flowers are produced simultaneously on one flower stem, resulting in doubleness. Sometimes a flower is produced much earlier, resulting in the production of a simple vegetative segregate on a double variety or sometimes the flowers coming out on one stem are produced successively, resulting in the telescopic appearance as exhibited by hybrid 5333.

Appearance of rose color of petals in a cross between carmine and yellow.—It will be recalled that the hybrids reported in this experiment are F_1 progeny of a cross between a variety with carmine petals and another with yellow petals. Among these hybrids is one, No. 5340, that produces rose petals. The appearance of the rose color may best be explained by recalling that the carmine parent arose as a bud sport of a rose plant.

It seems probable that the carmine sport, while carmine phenotypically, retains a determiner for rose color which reappears when conditions become favorable.

Because of the small number of hybrids raised, it is not advisable to consider the results of the cross statistically. It may be pointed out, however, that according to the assumption made above, there should result a greater number of carmine individuals than either yellow or rose, and this is exactly what happened, as shown by Table 1.

Before concluding the discussion of the appearance of rose in a cross between carmine and yellow, it is well to point out again that a knowledge of the vegetative origin of a variety is bound to prevent us from adopting a wrong explanation of the unexpected appearance of a character among hybrids. Taking as an example the appearance of rose in a cross between carmine and yellow already described, it is quite likely that had we not known that the carmine parent arose from a rose variety, we would be explaining the appearance of the rose color on the basis of complementary factors, an explanation that is not the best at all to offer at the present time.

Simple on double not involving mutation of a factor.—It has been pointed out that the hybrids reported in this paper constitute the first filial generation of a cross between a simple flower produced on a branch of a double variety and another simple flower of a simple variety. The fact that nearly half of the hybrids turned out to be double shows that the appearance of the simple flower on a branch of a double variety was not due to a mutation of a factor for doubleness into that for singleness, this conclusion being supported by the additional evidence that the branch that once produced the simple flower continues to produce double flowers.

Inheritance of doubleness.—Table 1 shows that of the eight hybrids obtained four were single and four were double, suggesting that one of the parents was homozygous and the other heterozygous. In the past I have performed numerous crosses between simples and as no doubles have been produced this way it may be concluded that simpleness is a homozygous recessive while doubleness is a heterozygous dominant. *Dd* may represent doubleness and *dd* simpleness. $Dd \times dd$ will result in $2Dd : 2dd$, or 50 per cent double and 50 per cent single. The somatic segregation of a single flower from a double may be explained by *D* of *Dd* changing to *d*.

Inheritance of the somatic segregate carmine.—In all the crosses which we have made in the past between rose and yellow, no carmine ever appeared among the hybrids. Furthermore, selfings made of either rose or yellow never produced carmine. These facts indicate that in the carmine hybrids produced in the cross Mutant Simple Carmine × 19 Pink 12396–104, which cross may for convenience be stated as *carmine* × *yellow,* the carmine was due to the mutant carmine and not to any recessive carmine combined with the pink of the original rose parent of the carmine segregate. These facts also prove that while carmine appeared as a somatic segregation, the change affected the germplasm with the result that it became heritable sexually.

SUMMARY

1. This paper reports three cases of somatic segregation found in double varieties of *Hibiscus rosa-sinensis* Linnæus in the Philippines; namely, (*a*) a periclinal chimera in a flower of the Double Salmon, (*b*) a branch of a Double Rose producing double carmine flowers and serving as the origin of our Double Carmine variety, (*c*) single flowers being produced by branches of Double Rose and Double Carmine varieties.

2. Through the production of the simple flowers by the Double Carmine variety, it was possible to cross this with a simple yellow variety. Among the hybrids produced by this (double carmine × simple yellow) cross there was a carmine plant and a rose individual, showing that while the carmine sport is carmine phenotypically, it retains the rose determiner.

3. The carmine somatic segregate was found to be sexually heritable.

4. The somatic segregation consisting in the production of simple flowers by a double branch does not seem to have involved the mutation of a factor.

5. Attention has been called to the fact that a somatic segregation which does not affect the germplasm and is not, therefore, sexually heritable is likely to confuse the results of a given cross in which one of the parents is a variety that has originated as one such vegetative segregate. It is quite likely that the failure of a character of a given parent to appear in any of its hybrid offspring may be traced to this cause. This makes it important that we know the vegetative origin of our horticultural varieties or clons.

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ILLUSTRATIONS

PLATE 1

A Double Rose hibiscus plant showing in the left circle a normal double flower and in the right circle the simple flower which arose as a vegetative segregate.

PLATE 2

Hibiscus (19 Pink–12396–104 $\times$ Mutant Simple Carmine) F_1.

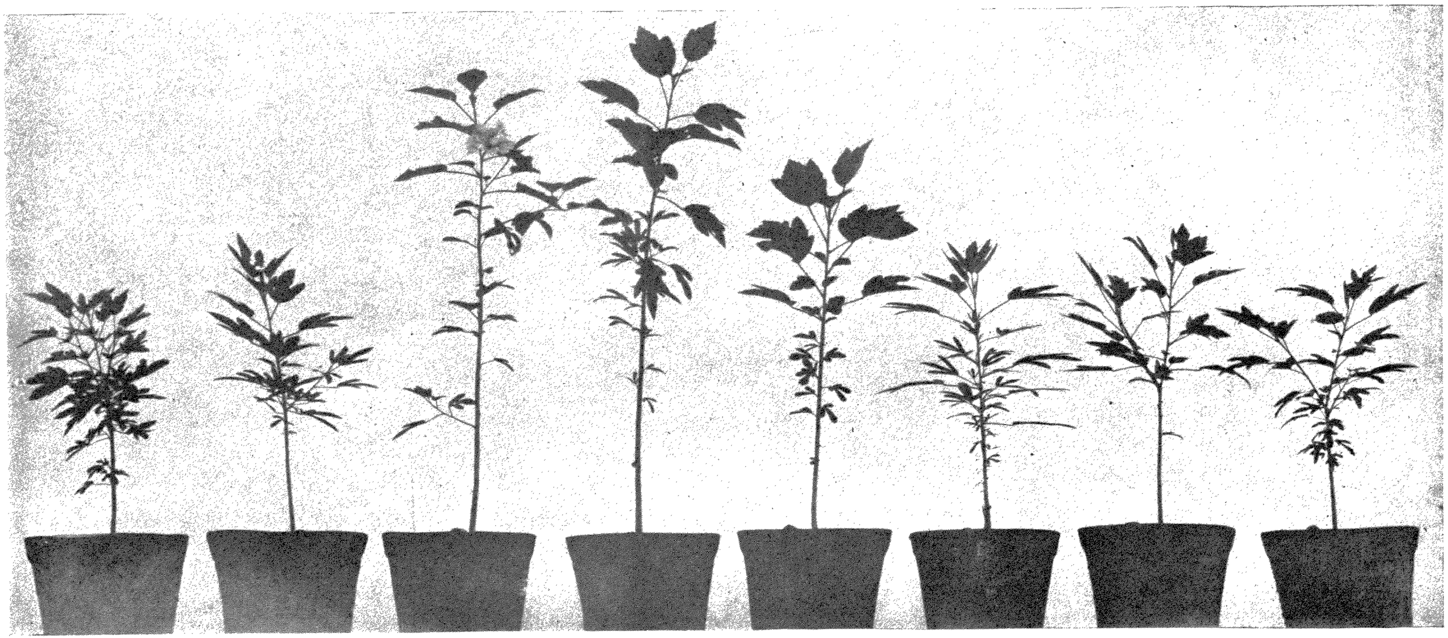
PLATE 3

FIG. 1. Hibiscus hybrid 5340, showing its double flower.
2. Hibiscus hybrid 5333, showing its double flower.

TEXT FIGURE

FIG. 1. A periclinal chimera shown by a flower of the Double Salmon hibiscus.

PLATE 1.



5334 5337 5340 5339 5337 5336 5333 5335

PLATE 2.

1 2

PLATE 3.

DAYTIME RESTING PLACES OF ANOPHELES MOSQUITOES IN THE PHILIPPINES

FIRST REPORT [1]

By Paul F. Russell

Chief, Malaria Investigations, Bureau of Science, Manila

FOUR PLATES

INTRODUCTION

Referring to the resting places of anophelines, Boyd(1*a*) in his very useful textbook on malariology summarizes as follows the places where one should look for the adults of *Anopheles* in the daytime:

1. Inside houses, especially the sleeping rooms, the darker corners, the ceiling, the wall behind furniture and pictures, dark clothing, or underneath furniture.
2. Underneath buildings. On leeward side of chimney bases and on windward side of joists.
3. In stables, pigsties, chicken houses, kennels, hutches, etc. when occupied.
4. In porches and verandas.
5. In privies.
6. Under bridges and in culverts.
7. On the shady side of road-cuts, stream and ditch margins having precipitous banks; in open wells, under ledges, and in caves.
8. On weed grown piles of brickbats and stones.
9. In the interior of hollow trees, or in the spaces between buttressing roots.
10. On the underside of leaves in dense thickets, or in clumps of shrubs and annual plants, perhaps in clumps of high grasses as well.
11. In cracks in the ground.

Hehir(2) referring to the adult anophelines of India, writes as follows:

Out-houses, bath-rooms, damp go-downs, shaded verandahs, cow-sheds, coach houses, garages, stables, unoccupied thatched houses, with dirty

[1] The International Health Division of the Rockefeller Foundation, of which the author is a field director, is coöperating with the Bureau of Science of the Philippines in malaria investigations. Mr. Domingo Santiago, field inspector of malaria investigations, made the routine catches reported in the tables.

soot-covered walls, are special day resorts for anophelines. In a native village or bazaar select huts that are near a pond, water channel or other breeding place of mosquitoes. Some favour the thatch beneath the eaves of huts and houses and require a ladder to reach them. Anophelines are rarely seen on whitewashed walls in the daytime and seldom at night. They may often be found in holes in walls, or in the corners of rooms, under beds and tables, in cupboards, on dark clothes in rooms; behind pictures, doors, furniture, in open fire-places and chimneys, in lavatories; under porches and in sheds, under bridges and culverts, in wells and unscreened cisterns; they are fond of hiding in old boots (Wellingtons and polo boots especially), on saddles—leather seems to attract them. We may see them at night wandering about the shady side of the mosquito net. The wooden rafters of thatched houses are a favourite retreat. In such shady places they are readily captured as they are probably asleep, and it is usually easy to place the butterfly net or mouth of the test-tube quickly and quietly over them. The distribution of some species of Anopheles is very local, hence it is necessary to examine as many likely places as possible.

From these descriptions one might imagine that it is never a difficult matter to find adult anophelines in the daytime in localities where abundant breeding is known to exist. But as a matter of fact malaria surveys in the Tropics have frequently in the past been handicapped because adult *Anopheles* mosquitoes, especially of the species carrying malaria, could not be captured in their daytime resting places. These shelters have often defied careful search by skilled field inspectors.

Boyd(1b) refers to this fact and comments that Oriental anophelines appear to be much less inclined to linger about dwellings than do their relatives elsewhere.

MacGregor(3) in his excellent manual for mosquito surveys cautions that it is well to note that certain species of anophelines which enter houses to bite the inhabitants rarely remain in the house after they have fed. They always attempt to get out of doors immediately after feeding. Consequently, the presence of these species is not to be detected by a daytime search.

Hackett,(4) who has had wide experience with anophelines in various parts of the world, wrote after a visit to the Orient, as follows:

I had no idea until I visited the Far East how difficult it is to lay hands on the adults of most of the principal malaria carriers.

LITERATURE

Without attempting an exhaustive survey of the literature several references may be cited as of interest in connection with this subject. These make it obvious that uniformity of results

has not been the rule. In India, for example, it has not always been a difficult matter to make daytime catches of adult anopheline mosquitoes. Refer again to Hehir.(2) Also note a report by Christophers(5) of some malaria surveys in 1925. In this report Christophers writes as follows:

> Anopheles in the houses at the time of my visit, though no longer very numerous, were to be obtained without great difficulty . . . Adult anopheles at Manharpur were fairly abundant in cow-sheds, etc., at the Babus' old quarters.

Other Indian references could be cited which indicate that adult *Anopheles* have been caught in daytime resting places in the course of malaria surveys; but there have been real difficulties, for Christophers, Sinton, and Covell,(6) in their guide for malaria surveys, comment as follows:

> If catches of adults made in the houses are carefully and critically examined in relation to the breeding places, and other catches of adults made in the open, a very great deal may be learnt about the behavior of Anophelines in particular circumstances. This work however has seldom been attempted and there is consequently a large field for enquiry on such lines.

In Ceylon only recently have daytime searches for adult *Anopheles* been successful. For example, James and Gunasekara(7) reported that adult anophelines were scarce and difficult to find. Barnes and Russell(8) wrote, "It has generally proved difficult to find the resting places of anopheles mosquitoes within village houses." Carter(9) in his very complete report on malaria and anopheline mosquitoes in Ceylon wrote:

> Adult *Anopheles* were not always abundant even although the time chosen for the visit appeared suitable, and on several occasions considerable difficulty was experienced in obtaining what were relatively small numbers.

It was therefore notable when Carter and Jacocks(10, 11) by paying particular attention to the matter were able to find between 9 a. m. and 4 p. m. considerable numbers of *Anopheles* resting on walls and hangings of village huts, small bungalows, and coolie barracks in various localities in Ceylon. As a result they were able to prove the importance of *A. culicifacies* as a malaria carrier in Ceylon by actual sporozoite findings in wild-caught specimens, something which had never been done conclusively before. Plate 1, fig. 1, shows the type of coolie barracks in which *A. culicifacies* were caught in the daytime, as demonstrated to me in November, 1929.

In British Malaya, while there have been reports of daytime catches of *Anopheles* mosquitoes, not many records are to be found. In the 1919 report of the Malaria Bureau(12*a*) there is reference to 15 adults caught in thirteen days search at Perhentian Tinggi. In the 1922 report (12*b*) it is noted that 10,327 adults had been caught in houses but apparently none were *A. maculatus*, the chief malaria-carrying species. In the 1923 report(12*c*) there is a record of 342 adult mosquitoes caught on a Johore estate in the houses. Of these 335 were *A. maculatus* and 11.5 per cent of the 199 dissected were found to be infected.

From personal experience in the Straits Settlements and in Kedah, I know that it is difficult to find adult *A. maculatus* in daytime resting places. In typical Malay houses they are seldom to be found, and they do not rest under such houses. In the darker and damper coolie barracks, or lines, they are more apt to be found, but even here the catch of anophelines seldom includes *A. maculatus*.

From the Dutch East Indies have also come reports both of good catches of adult mosquitoes and of meager results. Van Breemen(13) reported catching large numbers of *A. ludlowi* inside houses. In one locality adults were regularly caught, although larvæ could not be found. Swellengrebel and others(14) had no difficulty in catching *A. ludlowi* adults but speak of "many other species which leave the house shortly after feeding or which do not feed within the house. These species should be caught in the daytime on plants or trees or under the house or in the evening on man, cows or principally on buffaloes . . . catching on buffaloes is a precious method to collect species not to (be) found in houses." Schuffner and others(15) had the same experience and point out that *A. ludlowi* "is not found in empty houses." These authors(15) speak of other anophelines which after feeding "fly away again and hide themselves in trees, shrubs, ditches or other cavities."

But even *A. ludlowi* has not infrequently been elusive. Brug and Walch(16) in Solo reported, for example, that "five coolies under the supervision of a sanitary inspector could not catch more than 6 anopheles in a kampong such as Tjinderedjo, where at that time the parasite index of the children was 90, that for the adults 65." The authors(16) themselves had no success although they examined "dark corners and holes" and "crept under bedsteads." They finally succeeded in catching *Anopheles*

adults at night on buffaloes, although they had to offer a premium for the catches.

Again in Tegal, Walch and Soesilo(17) had to offer premiums for adult anopheline catches which, although in one case averaging forty-six, usually averaged less than two per catch.

Schuurman and Bokkel Huinink(18) on the south coast of Java caught fair numbers of anopheles adults "in and in the neighbourhood of the houses."

Essed(19) in reporting from Banjoewangi, Java east coast, comments that "if these hiding places such as mosquito-nets and dark recesses behind beds are not present, then one can seek in vain in the native and other houses for Anopheles."

As to the western tropics the situation is the same as in the East as regards catching adult anophelines. Some have reported good catches. For example, Le Prince and Orenstein(20) wrote of their experience in Panama as follows:

> While no suitable hiding places except vacant houses were without mosquitoes in the daytime, yet beyond the settled area none were found. . . . Large numbers were collected under houses where the breeze was sufficiently strong to make the lighting of a match difficult. These inhabited houses were on posts from two to ten feet above the ground. The dry weather ground-cracks under the houses were several inches deep and the mosquitoes collected in them.

On the other hand Boyd and Aris(21) wrote of their Jamaican experiences as follows:

> Searches made within houses during the day rarely yielded imagines, even though large numbers could be caught at night in the vicinity from a horse or mule as bait.

Stephens(22) in reporting a survey on a Venezuelan oil field wrote as follows:

> The search for anophelines in the native huts in the daytime was completely fruitless, and culicines also were very scanty. This condition was in marked contrast to those observed by me in the neighborhood of Lake Valencia, which I visited on my way home, where in the daytime, in the verandah of a hut it was easy to collect numerous anophelines, embracing three different species.

In Porto Rico Earle(23) relies not on routine daytime catches but on traps baited at night with such animals as calves or horses. He has been very successful with these traps. This is true also of Manalang(23, 24) in the Philippines.

THE PHILIPPINES

In the Philippines as elsewhere in the Orient it is not an easy matter to make routine daytime catches of anopheline adult mosquitoes. Refer again to Hackett(4) who wrote:

> In the seven days I spent in the [Philippine] Islands I did not catch a single one [*A. minimus*] although a sporting colleague offered as high as a peso [50 cents gold] apiece for adult specimens. At the same time the larvae were abundant.

Manalang, who has made extensive and notable studies on *A. minimus* (*A. funestus*) in the Philippines, writes: (25) "The adult mosquito is typically 'wild' in that it is very seldom found in the ordinary nipa house at night, much less in the day time." The reason may sometimes be as suggested by Walker and Barber(26) that it is the custom of the people in the rural districts to wash clothes and bathe in the streams, often in the early morning or evening, thus affording ample opportunity to the forest-loving anophelines. These observers,(26) however, made fair daytime catches of adult mosquitoes in houses in Mindoro and at Iwahig. In the latter place, a penal colony, the catches were chiefly inside mosquito nets which had been badly adjusted. They found only a few imagines along the banks of streams or in crab holes. They suggested in their report(26) that certain meteorological conditions influence the dispersal of adults. Their negative results were in localities having at the time hot and dry weather.

There have been no records of routine daytime catches of adult *Anopheles* in the Philippines. Where these adults, particularly *A. minimus* adults, go in the daytime has been and still is a question. This paper gives some information, but much more investigation along this line is required.

The typical Filipino nipa house in rural areas is built high off the ground. It is light, airy, and dry. It contains as a rule very little furniture and no beds. Roofs may be either of tin or thatching (Plate 1, fig. 2). At first glance it would seem as though *Anopheles* mosquitoes would find ideal sheltering places under such houses. In the Southern United States it has been my experience, common to that of many others, that where breeding is abundant it is more usual than not to find adults of *A. quadrimaculatus*, the malaria carrier, under houses resting on the sides of beams. In repeated searches in the Tropics I have so far always failed to find mosquitoes in such places.

Furthermore, *Anopheles* mosquitoes are rarely to be found inside such houses in the Philippines.

ROUTINE COLLECTIONS

During the last quarter of 1930 routine weekly catches were attempted not only in certain houses (as shown in Table 1) but also on the sides of a well (Table 2), along a stream bank (Table 3), and in the cracks of a stone wall (Table 4). These catching stations were all in or near Calauan, Laguna Province, Luzon Island.

TABLE 1.—*Adult Anopheles mosquitoes caught inside houses during routine weekly collections October to December, 1930, Calauan. Only nighttime catches are shown as no Anopheles mosquitoes were caught inside houses by day. No traps used.*

Species.	Sex.		Total.
	Male.	Female.	
Anopheles subpictus (fresh water)	2	3	5
Anopheles vagus (Philippine forms)	3	5	8
Total	5	8	13

TABLE 2.—*Adult Anopheles mosquitoes caught on the sides of an open well, Masiit, October to December, 1930, in routine weekly collections.*

[Catching time about ten minutes once a week.]

Species.	Sex.		Total.
	Male.	Female.	
Anopheles kochi (Donitz 1901)	4	8	12
Anopheles tessellatus (Theobald 1901)	36	56	92
Total	40	64	104

The well used as a catching station is of the surface type having no protection around the top except long grasses and low bushes. The water level is about 7 feet below the ground surface and the well is about 15 feet deep. The sides of the well are of earth, and there are places where the top overhangs miniature caves in which adult mosquitoes are apt to be found among exposed roots. Here it is darker, damper, and more protected. The water of the well is not much used, and *A. tessellatus* is breeding in it (see Plate 3, fig. 3, and Table 2).

TABLE 3.—*Adult Anopheles mosquitoes caught along a stream bank, Masiit, October to December, 1930, in routine weekly collections.*

[Catching time about thirty minutes once a week.]

Species.	Sex.		Total.
	Male.	Female.	
Anopheles bancrofti var. *pseudobarbirostris* (Ludlow 1902)	3	3	6
Anopheles barbirostris (van der Wulp 1884)	6	7	13
Anopheles fuliginosus (Giles 1900)	1	3	4
Anopheles kochi (Donitz 1901)	4	8	12
Anopheles minimus (Theobald 1901)	126	272	398
Anopheles tessellatus (Theobald 1901)	36	56	92
Anopheles vagus (Philippine form)	52	93	145
Total	228	442	670

TABLE 4.—*Adult Anopheles mosquitoes caught along an old stone wall, Calauan, October to December, 1930 in routine weekly collections.*

[Catching time about fifteen minutes once a week.]

Species.	Sex.		Total.
	Male.	Female.	
Anopheles barbirostris (van der Wulp 1884)	2	1	3
Anopheles hyrcanus var. *sinensis* (Wiedeman 1828)	0	1	1
Anopheles kochi (Donitz 1901)	3	9	12
Anopheles minimus (Theobald 1901)	6	9	15
Anopheles philippinensis (Ludlow 1902)	1	0	1
Anopheles tessellatus (Theobald 1901)	2	26	28
Anopheles vagus (Philippine form)	75	64	139
Total	89	110	199

In Plate 2 is shown the stream along which catches of adult *Anopheles* were made. It is a typical *A. minimus* breeding place of the Philippines. Plate 3, fig. 2, shows a catching station. Here the stream bank is eroded and is overhung by vegetation, so that a darkened, damp, and sheltered resting place is formed (see Table 3).

Another resting place for adult anophelines in the Philippines is shown in Plate 4, figs. 1 and 2. This stone wall is in an old cemetery about 1 kilometer from the nearest mosquito breeding places. The wall is well shaded by high bushes, vines, and trees. There are numerous large cracks and crevices in which mosquitoes find darkened, sheltered resting places which are, however, not very damp, in fact they seemed distinctly dry.

From these findings it appears that routine daytime catches of *Anopheles* imagines in the Philippines will have to include not only human habitations or animal houses, but primarily natural shelters such as cracks, crevices, and caves near or in the ground, not necessarily near breeding places. Further searching in different types of houses and with nets among grasses and bushes may reveal other sheltering places, but at the present time, for the rural Philippines, the records in the tables of this report may be taken as indicating the preferences of adult *Anopheles* for their daytime resting places. For the catching of *Anopheles* imagines in the Tropics trapping would seem to be the most effective method, although traps still leave much to be desired.

SUMMARY

A brief review of the problem of catching adult *Anopheles* mosquitoes in their daytime resting places in the Tropics is presented. Some observations are given as to the situation in the Philippines.

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ILLUSTRATIONS

[Photographs by the author.]

PLATE 1

FIG. 1. Coolie barracks in Ceylon in which adult *Anopheles culicifacies* were regularly caught in the daytime.

2. Typical rural Filipino houses.

PLATE 2

A typical *Anopheles minimus* breeding place in the Philippines.

PLATE 3

FIG. 1. Looking obliquely at the side of a well overhung by roots and grasses. (See Table 2 and the text.)

2. A catching station for adult *Anopheles minimus* mosquitoes.

PLATE 4

FIG. 1. Stone wall in old Calauan cemetery. (Time exposure.)

2. Close view of resting places of *Anopheles* on a stone wall. (Time exposure.)

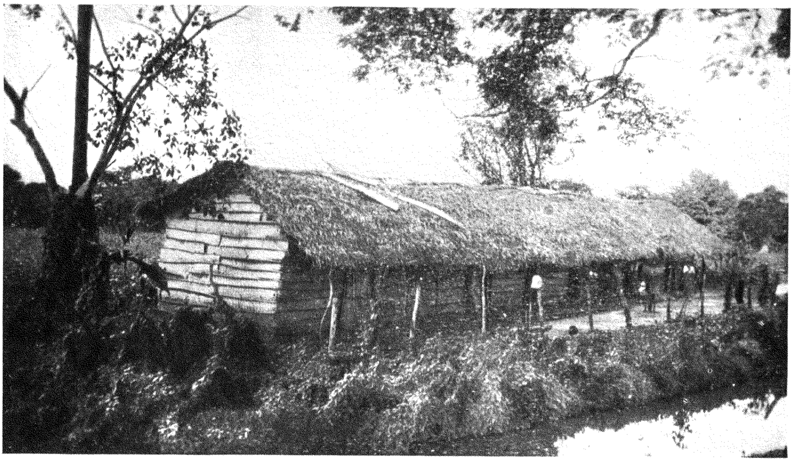

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PLATE 1.

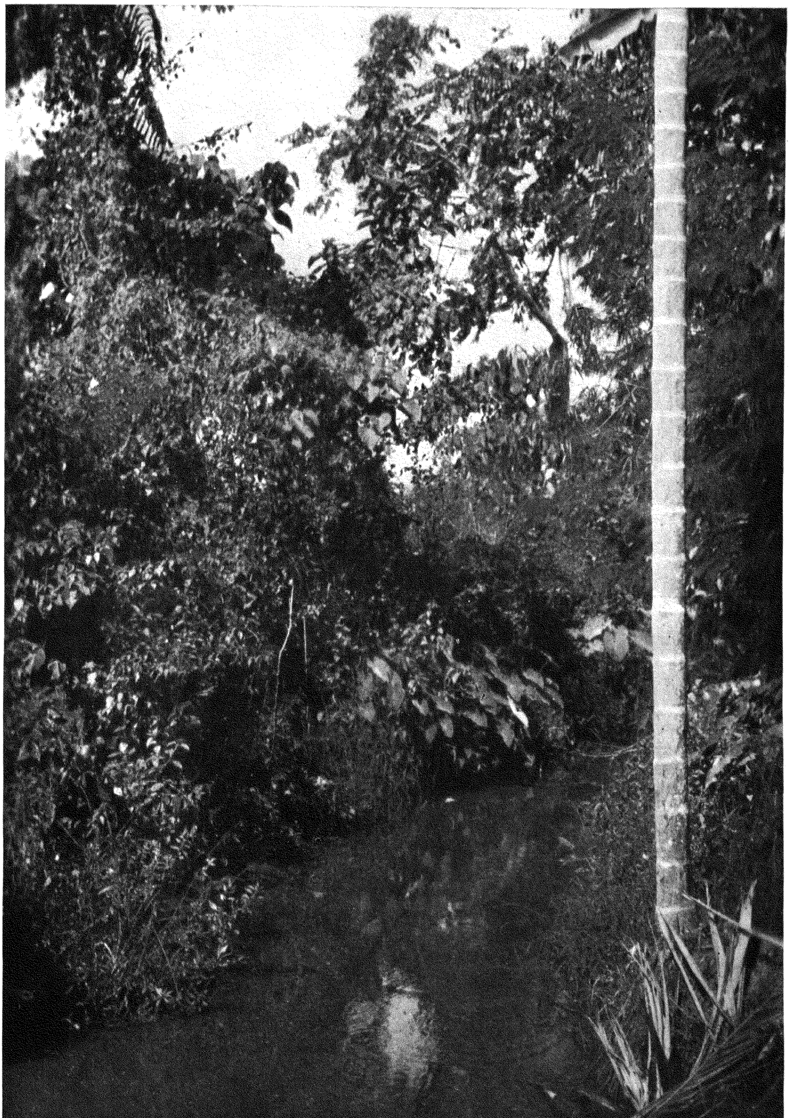

PLATE 2.

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PLATE 3.

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PLATE 4.

AVIAN MALARIA STUDIES, III

THE EXPERIMENTAL EPIDEMIOLOGY OF AVIAN MALARIA; INTRODUCTORY PAPER [1]

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TWO PLATES AND THREE TEXT FIGURES

INTRODUCTION

Although epidemiology as an ancient science dates back to Hippocrates(1) it has had remarkably little experimental study. Prior to Hippocrates epidemics were viewed entirely from a supernatural or metaphysical standpoint. Witness, for example, the Chaldaic *malus annus*, or evil year. In the Hippocratic writings can be seen the first attempts to identify the natural factors causing epidemics. Hippocrates gave little credence to mysterious agents of the superstitious, but a conception of infection was totally lacking, and so explanation of external causes of epidemics, as based on Hippocrates's observation, involved careful consideration of the constitution of the atmosphere, of cosmic influences, and seasons. This modest theory and Galen's suggestive writings as to a distinction between exciting and predisposing causes were unheeded until Guillaume de Baillou (1538–1616),(2) physician to the Dauphin of Henri IV, reintroduced the idea that certain seasons and certain years are by their peculiar innate nature subject to certain diseases. Baillou has been called "the first epidemiologist of modern times."

[1] The first experiment reported in this paper was done in the Department of Tropical Medicine, Harvard University Medical School, through the courtesy of Prof. R. P. Strong and with the assistance of the International Health Division of the Rockefeller Foundation. The second and third experiments were done at the Bureau of Science, Manila, where the author is chief of malaria investigations in which the bureau and the division are coöperating. Misses Amparo Capistrano and Filomena Villacorta, of the staff of malaria investigations, assisted in the blood examinations in the last two experiments. Mrs. Isabel Ramos, also of the staff, assisted in handling the mosquitoes.

Thomas Sydenham (1624–89) expanded this theory of *genius epidemicus*, or "*epidemic constitutions*." Delving into accounts of outbreaks of disease in London over a 25-year period, he attributed great importance to the influence of season and climate, not only in the origin of epidemics but even in determining predominant clinical manifestations of a given disease. Smallpox under one epidemic constitution might be a very different matter as a disease and as an epidemic from smallpox under another constitution.[3, 4, 5, 6]

Since Sydenham's time, except for an incorporation into the concept of epidemic constitutions of the fact of infection by demonstrable pathogenic organisms, there has been surprisingly little progress in the development of the theory of epidemic disease. Even to-day epidemics of malaria, influenza, plague, cholera, and smallpox, for example, are in some phases as mysterious as they were to Hippocrates.

Present belief is in general as stated by Topley: "The origin and spread of any epidemic of microbial infection depends upon variations in the normally existing relations between living organisms; and the actual outbreak of disease, the occurrence of clinically recognisable cases, is only the end-result of a progressive disturbance of this normal equilibrium."[63] This being true, Topley goes on to point out, the problems of epidemic disease thereupon assume an aspect more biological than medical. This last observation is especially true of malaria.

Not to mention the classical and historical methods, there are, as Brownlee[14] states, three ways in which the biological basis of epidemics may be sought. There may be observation of the mode of progress of the epidemic, in the first place, as it occurs in nature or, in the second place, as during an experiment. In the third place there may be an examination of accumulated statistical information at our disposal.

Hippocrates, Baillou, and Sydenham followed the first way. In their footsteps have come Maximillian Stoll (1742–1787), of the old Vienna school; Lancisi (1655–1720), the Italian; and more recently Hamer,[7–10] Crookshank,[11, 12] and many others.

The third way was opened by William Farr (1807–1883), author of a "law" to the effect that "the curve of an epidemic at first ascends rapidly, then slopes slowly to a maximum, to fall more rapidly than it mounted." Greenwood, Brownlee, Ronald Ross, and others have followed Farr and their epidemic curves are usually of the normal bell-shaped Farr type.[13–26]

Ross, in particular,(19–26) ever since his epochal discovery of the transmission of malaria by mosquitoes, has been interested in the mathematics of the spread of malaria. He has applied the theory of probabilities to the statistical prognosis of epidemics, dealing particularly with the statics or equilibrium of malaria. His equations have been carefully analyzed and amplified by Lotka,(27–29) who has dealt more especially with the kinetics of malaria. Others who have dealt with malaria mathematically are Waite(30) and McKendrich.(31, 32) As yet, however, there are no data available for numerical comparison between mathematical formulæ and observed conditions.

The second way of approach to the biological basis of epidemics—the way of direct experimental epidemiology—has only recently been taken. Reports of Löffler,(33) Danysz,(34, 35) Bahr,(36) Liston,(37) Xylander,(38) Mühlens,(39) and Bainbridge(40) were suggestive. The first direct attempt at experimental epidemiology was made by Topley and his colleagues(41–72) in England. They have carried out notable studies with mouse pasteurellosis infections.

These men have studied the epidemiological history of a "little community, wholly exempt from *res angusta domi* in any sense of the phrase, well fed, well housed, with nothing to do but eat, fight, make love, and sleep, shielded from contamination by supermedical officers of health, and most efficient birth control."

They have "brought the doctrine of Epidemic Constitutions within the compass of natural inquiry."(62)

One of their most important findings has been that "a pasteurellosis will continue as a fatal infectious disease within a population of mice replenished wholly by additions of normal animals, not infected prior to immigration, over a period of more than 3¼ years, that is through a period longer than a generation."(58) In other words, the admission to a controlled community of mice of individuals not having the disease that is epidemic in that community is a danger to that community. Here then is a suggestive lead for investigation in human herds, for much of our community prophylaxis ignores completely incoming normal persons.

Outstanding and independent work in experimental epidemiology in villages of mice has been done at the Rockefeller Institute by Flexner, Webster, and associates. These studies have shown that epidemics may arise from increased dosages of the patho-

genic organism. There is acceleration or diminution in response to factors that determine the susceptibility or resistance of the population. It appears from this work that the course of events in the epidemics was based on the distribution of the bacterial parasite among the population at risk and the susceptibility of the individuals comprising the population. Bacterial virulence does not appear to have been a changing factor. Later studies at the institute have been with respiratory infections in rabbits and with fowl cholera.(73–123) Neufeld, Lange, and coworkers, at the Robert Koch Institute in Berlin, have also investigated problems of experimental mouse typhoid.(124–133)

Still other attempts to study epidemiology by controlled experiments are those of Perla and Lurie(134–139) with artificially induced epidemics of tuberculosis in rabbits. Koch(140) observed that rabbits and guinea pigs exposed in the same room with tuberculous animals for a longer period than four months not infrequently acquire tuberculosis. Perla and Lurie have attempted well-controlled experiments on the basis of observations from spontaneous outbreaks.

There are many references in the literature to spontaneous epidemics of disease among laboratory animals and these often afford excellent although uncontrolled opportunities for study. As an example the reports of Theobald Smith and Nelson,(141, 142) on paratyphoid in guinea pigs, may be cited.

Such natural episodes cannot, however, take the place of experimentally produced epidemics which, although simulating the usual, are yet unusual in that certain factors are manipulated and controlled in a uniform way.

These references to studies in the experimental epidemiology of bacterial diseases are given not because they shed much light on the spread of malaria in a community of birds. They are cited, with such bibliography as is available to the author, because they illustrate a new method of approach to problems of epidemiology, whether the disease in question be due to bacteria directly passed from individual to individual or due to protozoa carried by an arthropod host. Such experiments inaugurate a new era in epidemiology.

It is undoubtedly open to question whether experimental epidemics within the confines of small cages accurately reflect the phenomena of natural outbreaks of disease, and it is partly to answer this question that the following experiments have been

undertaken. While the immediate findings of the experiments here reported are meager yet the general way of approach may lead into fertile territory.

So far as the author is aware this is the first report to be published on the experimental epidemiology of malaria, based on miniature epizoötics of the disease in laboratory animals. There is a brief reference in Gill's excellent textbook on epidemiology, to some abandoned studies with experimental malaria in sparrows. No other has been found in the available literature.

GENERAL EPIDEMIOLOGY OF MALARIA

Certain fundamental considerations governing the spread of malaria are well known. Before a new case can arise in a community the following conditions must obtain progressively:

1. There must be a gametocyte carrier; that is, a person with sufficiently numerous and normal mature male and female gametocytes circulating in the peripheral blood,—the seed.
2. A female anopheline mosquito capable of acting as a beneficent host to malaria parasites must travel to the skin of the gametocyte carrier, push its proboscis into a blood vessel, and suck enough gametocytes into its gut to insure that it will become host to the critical number, or more, of sporozoites.
3. The mosquito that has thus successfully fed must live long enough and must maintain conditions of temperature and bodily state favorable enough to make possible the development of malaria parasites to the sporozoite stage, with lodgement of these sporozoites in the salivary glands.
4. This mosquito must make its way successfully to the skin of a susceptible person and inject a sufficient number of sporozoites to cause a new infection,—the sower and soil.

These fundamental and undisputed considerations remove much of the mystery from malaria epidemics, but they have not made the situation entirely clear. Anophelism sans malaria; malaria sans anophelism; years or regions of hyperendemicity; incidence regressions sans prophylaxis; recurrences coincident with active control; the effect of changed environment, of overcrowding, of malnutrition; these and other phenomena of malaria require further elucidation. The studies to which the present paper is an introduction have been undertaken in the hope that they may send light, however dim, into some of the hidden recesses of the epidemiology of malaria.

AVIAN MALARIA

The study of avian malaria has helped in the solution of some of the problems of human malaria. MacCallum's dicovery of the exflagellation of *Haemoproteus;*(144) Ross's momentous discovery of the transmission of *Proteosoma* by mosquitoes;(145) studies in relapse, drug therapy, biology and biometry of parasites, and host immunity in avian malaria by Whitmore,(146) the Sergents,(147) Roehl, and others,(148) Hartman,(149) and Huff(150) have augmented our understanding of human malaria.

It seems logical, therefore, to expect that a careful experimental study of epizoötics of malaria in laboratory birds may enrich our knowledge of the epidemiology of human malaria.

PROCEDURE

1. *Birds.*—The birds used in these experiments were canaries (*Serinus canarius*), purchased from dealers. Up to the time of writing this report two hundred canaries have been purchased and examined, all being negative. In no case has a bird infected with malaria been received from a dealer.

As will be seen below in the three preliminary reports of experiments, there was a high mortality in the first case but a low one in the second and third cases. This illustrates the fact that while some lots of canaries do poorly under laboratory conditions, others do very well.

2. *Parasites.*—The parasite used in all of these experiments was *Plasmodium cathemerium* Hartman, 1927.(151) In the first experiment the original Baltimore strain was used. In the last two experiments a strain isolated by Huff in Boston was used.(152) It is a matter of common knowledge among those who have worked with this plasmodium that canaries are susceptible to it. In over two hundred cases, in the experience of the author, it has invariably established itself in a bird upon needle inoculation. Successful transmission by mosquitoes occurred in the first and third experiments of this paper. It has also been reported by Huff(153) and others.

3. *Mosquitoes.*—The mosquito used in the first experiment was *Culex* (*Culex*) *pipiens* Linnæus, 1758. In the second and third experiments the species used was *Culex* (*Culex*) *quinquefasciatus* Say, 1823, (*C. fatigans*). That these species are susceptible to infection with avian malaria parasite has been shown in general for *C. quinquefasciatus* by Ross,(145) Daniels,(154) James,(155) and others. Huff(153) has shown in particular that

C. quinquefasciatus is susceptible to *P. cathemerium* Hartman, 1927. The susceptibility of *C. pipiens* has been demonstrated in general by Ruge,(156) the Sergeants,(157) and Neumann.(158) Huff (153) has shown in particular that *C. pipiens* is susceptible to *P. cathemerium* Hartman, 1927.

4. *Environment.*—The cages have been approximately 3 by 2 by 2 feet in size (Plate 1). In the first experiment the cage had glass sides and was kept in a special room equipped with thermostat and electric heater so adjusted that the temperature remained at about 80° F. (range 79° to 82° F. or 26.0° to 27.7° C.). High relative humidity was maintained. The birds were in a wire cage placed inside the mosquito cage in such a position that cleaning and feeding could be carried on with a minimum of disturbance.

The second and third experiments were done in Manila where the temperature is at no time unsuitable for mosquito breeding. Glass sides were not used in the Manila cages (Plate 2).

6. *Controlled factors.*—It will be realized from the foregoing paragraphs that many factors underlying the spread of malaria among birds could be manipulated in these experiments. A definite number of susceptible individuals were shut in a controlled area in close association with a definite number of gametocyte carriers. The carriers were changed from time to time, as indicated by daily blood smears, in order to keep a plentiful supply of gametocytes available.

Just how many gametocytes per 10,000 red blood cells are required to infect a mosquito is not known. It may be pointed out that Darling(159) found the limit of infectiousness in human malaria from *A. albimanus* to be one gametocyte per 500 leucocytes or 12 gametocytes per cubic millimeter of blood. As Huff(153) points out, if we assume the same to hold true for bird malaria and *C. quinquefasciatus* and assume further an anæmia of 2,500,000 red cells per cubic millimeter of blood, then a bird with only 0.048 gametocyte per 10,000 red cells would be infectious to mosquitoes.

In the experiments reported below, the carriers, with rare exceptions, were found upon examination to have 5 or more gametocytes per 10,000 red cells (see Tables 1, 2, and 3). If we assume with Huff, following Darling's work again, that an average blood meal is 0.0008 gram or 0.76 cubic millimeter (it is probably more) and also assume again an anæmia of 2,500,000 red cells per cubic millimeter of blood (it is probably not so

severe), then a single meal would mean 1,900,000 red cells and in the present experiments, 950 or more gametocytes (often several thousands).

TABLE 1.—*First experiment. Gametocyte counts.*

Date.	Bird No.	Smear.	Gametocytes per 10,000 red blood cells.	Date.	Bird No.	Smear.	Gametocytes per 10,000 red blood cells.
1929				1930			
April 17	2RH	++++	24	May 8	7RH	++++	730
April 18	2RH	+++	31	May 9	7RH	++++	619
April 19	2RH	+++	132	May 10	7RH	++++	988
April 20	115H	++++	163	May 11	8RH	+++	50
April 21	115H	++++	210	May 12	8RH	+++	32
April 22	115H	+++	92	May 13	8RH	+++	49
April 23	4RH	++++	20	May 14	8RH	++++	83
April 24	4RH	+++	8	May 15	8RH	+++	76
April 25	4RH	++	3	May 16	8RH	++++	51
April 26	3RH	+++	47	May 17	9RH	++	21
April 27	3RH	++++	108	May 18	9RH	++	17
April 28	4RH	+++	76	May 19	9RH	++	28
April 29	4RH	+++	55	May 20	9RH	++	7
April 30	6RH	+++	151	May 21	9RH	++	5
May 1	6RH	+++++	132	May 22	126H	+++	113
May 2	6RH	+++++	201	May 23	126H	++++	420
May 3	6RH	+++++	154	May 24	126H	++++	519
May 4	6RH	+++	95	May 25	43RE	+++++	581
May 5	6RH	++++	236	May 26	43RE	++++	690
May 6	6RH	++++	102	May 27	43RE	++++	834
May 7	7RH	++++	269				

TABLE 2.—*Second experiment. Gametocyte counts.*

Date.	Bird No.	Smear.	Gametocytes per 10,000 red blood cells.	Date.	Bird No.	Smear.	Gametocytes per 10,000 red blood cells.
1930				1930			
April 28	21R	++	1	June 9	51R	++	21
April 30	21R	+++++	114	June 10	43R	+++	31
May 1	21R	+++++	83	June 21	43R	+++++	1,070
May 4	21R	++++	42	June 24	33R	+	18
May 13	48R	++++	110	July 4	33R	+	5
May 14	48R	+++	155	July 7	34R	+	1
May 17	48R	++	95	July 10	34R	0	0
May 26	48R	+	5	July 13	U31	+	6
May 31	52R	++++	34	July 15	U30	++++	25
June 4	52R	+++++	14	July 18	U30	+++++	257
June 5	51R	+++++	317	July 24	U2	+++++	209

TABLE 3.—*Third experiment. Gametocyte counts.*

Date.	Bird No.	Smear.	Gametocytes per 10,000 red blood cells.	Date.	Bird No.	Smear.	Gametocytes per 10,000 red blood cells.
1930				**1930**			
August 14	U40	++++	310	August 30	U73	+++++	891
August 14	U41	++	35	August 30	U22	++++	364
August 14	U42	+++	29	August 30	U38	+++++	403
August 14	U36	+++	47	September 8	U84	+++++	905
August 21	U36	+++	54	September 8	U38	+	2
August 21	U88	++++	286	September 8	U93	++++	171
August 21	U89	+++	71	September 8	X12	+++++	238
August 21	U91	+++	92	September 16	U80	++	23
August 30	U37	+++++	1,037	September 16	J38	+++++	1,001

The mosquitoes were grown by the usual technic, for the most part inside the cage itself where feeding, mating, and egg-laying proceeded without difficulty. Daily counts were made of the adult mosquitoes, and from time to time increments of larvæ and pupæ were added to the cages (see Tables 5 and 6). Löffler's dehydrated blood serum mixed with litmus milk was found to be a satisfactory food for the larvæ. Raisins in sugar syrup were supplied for the male adult mosquitoes.

As to the susceptibility of the mosquitoes used in the first experiment it may be placed at about 45 per cent in accordance with results given in Table 4 of the very complete paper by Huff.[153] I was indebted to Huff for the stock of *C. pipiens*, which was the same as used in his experiments. At this point I would state that I am indebted to him not only for mosquito stock but also for generous criticism and guidance in many phases of this work.

In the second two experiments the susceptibility of the stock of *C. quinquefasciatus* may be placed for the purposes of this paper at about 48 per cent. This is based on one experiment where females of this species were allowed to feed on gametocyte-carrying birds so placed as to allow the insects leisurely and complete meals. Of thirty-one individuals that survived twelve days, fifteen on dissection were found to have oöcysts on the wall of the mid-gut. Experiments are in progress to determine the sporozoite rate which is lower.

As to the biting-frequency factor, data are being gathered but are not yet available.

As to the longevity of the mosquitoes in the experimental cages, Tables 4, 5, 6, and 7 give some preliminary information. Further observations are in progress.

TABLE 4.—*Experiment 5, cage E–H. Mortality of mosquitoes in an experiment cage (C. quinquefasciatus).*[a]

Date.	Adults counted.	Pupæ added.	Egg rafts removed.	Date.	Adults counted.	Pupæ added.	Egg rafts removed.
1931				**1931**			
January 20		176		February 11	37		
January 21	73	63		February 12	36		
January 22	100	160		February 13	26		
January 23	135	88		February 14	26		
January 24	192	138		February 15	10		
January 25	212	154		February 16	10		
January 26	295	74		February 17	9		
January 27	250	60	19	February 18	9		
January 28	280	42	8	February 19	9		
January 29	250		17	February 20	9		1
January 30	237			February 21	5		
January 31	137			February 22	5		
February 1	68			February 23	5		
February 2	110		4	February 24	5		
February 3	100		2	February 25	5		2
February 4	37			February 26	5		
February 5	37		1	February 27	2		
February 6	36			February 28	2		
February 7	39			March 1	1		
February 8	39			March 2	0		
February 9	39			March 3	0		
February 10	39			March 4	0		

[a] Throughout this experiment two birds were kept in the cage to supply blood meals. Raisins in syrup were supplied for the males.

FIRST EXPERIMENT

Chart 1 illustrates the following summary of experiment 1.

February 17, 1929. Three hundred fifty larvæ and pupæ of *C. pipiens* put in special cage with nine canaries (none infected); temperature, 85° F.; humidity, 95 per cent.

March 1. First egg raft found inside cage.

April 17. Mosquitoes in cage feeding, mating, laying eggs, and dying at such a rate that the daily count of females averages 100. Susceptible birds 1 to 9R put in cage. Also gametocyte carrier 2RH.

April 20. Gametocyte carrier 115H substituted for 2RH.

April 22. Susceptible 3R died with no evidence of malaria. 10R put in cage as replacement.

April 23. Gametocyte carrier 4RH substituted for 115H.

April 26. Gametocyte carrier 3RH substituted for 4RH.

April 28. Gametocyte carrier 4RH substituted for 3RH.

TABLE 5.—*Mosquito population during second experiment.*[a]

Date.	Mosquitoes counted.	Date.	Mosquitoes counted.	Date.	Mosquitoes counted.
1930		1930		1930	
May 16	758	June 15	405	July 15	635
May 17	877	June 16	415	July 16	639
May 18	894	June 17	421	July 17	653
May 19	888	June 18	378	July 18	635
May 20	829	June 19	271	July 19	651
May 21	815	June 20	372	July 20	496
May 22	798	June 21	307	July 21	571
May 23	749	June 22	343	July 22	492
May 24	817	June 23	408	July 23	516
May 25	791	June 24	478	July 24	543
May 26	644	June 25	435	July 25	535
May 27	569	June 26	456	July 26	454
May 28	442	June 27	557	July 27	418
May 29	338	June 28	576	July 28	445
May 30	310	June 29	604	July 29	496
May 31	312	June 30	621	July 30	530
June 1	319	July 1	846	July 31	513
June 2	382	July 2	812	August 1	460
June 3	383	July 3	880	August 2	458
June 4	364	July 4	746	August 3	456
June 5	456	July 5	669	August 4	457
June 6	457	July 6	663	August 5	432
June 7	496	July 7	692	August 6	429
June 8	503	July 8	677	August 7	421
June 9	403	July 9	656	August 8	412
June 10	440	July 10	683	August 9	438
June 11	405	July 11	669	August 10	441
June 12	459	July 12	783	August 11	482
June 13	420	July 13	718	August 12	439
June 14	413	July 14	727	August 19	425

[a] In this experiment the egg rafts were not removed from the cage. Additional pupæ were added from time to time as the population seemed to be falling. All counts were made at about 9 a. m. almost always by the same two individuals, their totals being averaged.

April 30. Gametocyte carrier 6RH substituted for 4RH.

May 3. Susceptible 1R died with no evidence of malaria; replaced by 11R.

May 4. Susceptible 4R died with no evidence of malaria; replaced by 12R.

May 5. If a maximum time of twelve days is allowed for development of sporozoites and six days for a prepatent period in a new infection, a case of malaria would appear on this day had a mosquito become infected the first night and lived to bite another bird on the twelfth day.

May 7. Gametocyte carrier 7RH substituted for 6RH. Susceptible 10R died with no evidence of malaria; replaced by 13R.

May 8. Susceptible 8R died with no evidence of malaria; replaced by 14R.

TABLE 6.—*Mosquito population during third experiment.*[a]

Date.	Mosquitoes counted.	Date.	Mosquitoes counted.	Date.	Mosquitoes counted.
1930		1930		1930	
August 15	806	August 28	557	September 9	834
August 16	881	August 29	459	September 10	949
August 17	859	August 30	629	September 11	896
August 18	847	August 31	792	September 12	1,061
August 19	779	September 1	1,043	September 13	863
August 20	757	September 2	875	September 14	834
August 21	723	September 3	735	September 15	849
August 22	670	September 4	631	September 16	961
August 23	390	September 5	639	September 17	863
August 24	423	September 6	812	September 18	743
August 25	518	September 7	821	September 19	705
August 26	662	September 8	814	September 20	717
August 27	548				

[a] In this experiment egg rafts were removed from the cage (see Table 7). Pupæ were added from time to time as the population seemed to be falling. The counts were made chiefly by one individual and usually at 9. a. m.

TABLE 7.—*Egg rafts removed from cage during third experiment.*

Date.	Egg rafts removed.	Date.	Egg rafts removed.	Date.	Egg rafts removed.	Date.	Egg rafts removed.
1930		1930		1930		1930	
August 19	5	August 30	47	September 14	6	September 23	2
August 20	5	August 31	52	September 15	5	September 24	36
August 21	4	September 3	10	September 16	5	September 25	23
August 22	15	September 5	3	September 17	2	September 26	0
August 23	1	September 6	106	September 18	32	September 27	0
August 24	6	September 8	22	September 19	64	September 28	28
August 25	3	September 9	66	September 20	6		
August 26	3	September 10	10	September 21	12		
August 28	7	September 11	36	September 22	2		

May 11. Gametocyte carrier 8RH substituted for 7RH. Susceptible 11R died with no evidence of malaria; replaced by 15R.

May 14. Susceptible 2R and 13R died with no evidence of malaria; replaced by 16R and 17R.

May 17. Gametocyte carrier 9RH substituted for 8RH.

May 22. Gametocyte carrier 126H substituted for 9RH.

May 23. Susceptible 6R and 16R died with no evidence of malaria; replaced by 11RH and 13RH.

May 25. Gametocyte carrier 43RE substituted for 126H. Susceptible 5R and 15R died with no evidence of malaria; not replaced because birds not available.

May 27. Replacements 37RE and 40RE put in cage. This day is notable for the fact that both 12R and 14R have positive blood smears.

May 29. Susceptible 17R died with no evidence of malaria; not replaced.

May 30. Replacement 45RE.

June 4. Bird 12R died of acute malaria.

June 5. Bird 9R has a positive blood smear. It has been in the cage since April 17 and escaped infection from about April 29 to about May 30.

May 6. Bird 14R died of acute malaria.

May 7. Bird 40E died with no evidence of malaria.

May 9. Bird 45RE died with no evidence of malaria.

May 11. Experiment stopped.

DISCUSSION OF FIRST EXPERIMENT

This first experiment was carried through to develop technic. It demonstrated that *C. pipiens* will propagate itself and maintain a colony in an experimental cage such as described. It made evident that *C. pipiens* feeds readily on birds in cages and that it will transmit malaria under these conditions. It also demonstrated that a high mortality may come about among birds free from malaria but purchased in the open market and kept under laboratory conditions. Each dead bird was carefully examined post mortem for evidence of malaria. Except in the cases of 12R and 14R no such evidence was found. The other birds died of a bacterial infection. This bacterial epidemic coincident with the experiment illustrates one of the occasional major difficulties in the study of avian malaria.

SECOND EXPERIMENT

Chart 2 illustrates the second experiment. Having moved from Boston to Manila it became necessary for me to develop a technic suited to different climatic conditions. This second experiment and the third are to be viewed in a preliminary way.

April 5, 1930. Four pans well stocked with larvæ and pupæ of *C. quinquefasciatus* put in cage with five birds.

April 12. First egg rafts.

April 27. Colony of mosquitoes is propagating itself strongly.

April 28. Susceptible birds XI, 2, 3, 4, 5, 6, 8, 9, and 10 put in cage. Also gametocyte carrier 21R.

May 13. Gametocyte carrier 48R substituted for 21R.

May 27. Gametocyte carrier 52R substituted for 48R.

June 4. Gametocyte carrier 51R substituted for 52R.

June 10. Gametocyte carrier 43R substituted for 51R.

June 21. Gametocyte carrier 33R substituted for 43R.

July 7. Gametocyte carrier 34R substituted for 33R.

July 11. Gametocyte carrier U31 substituted for 34R.

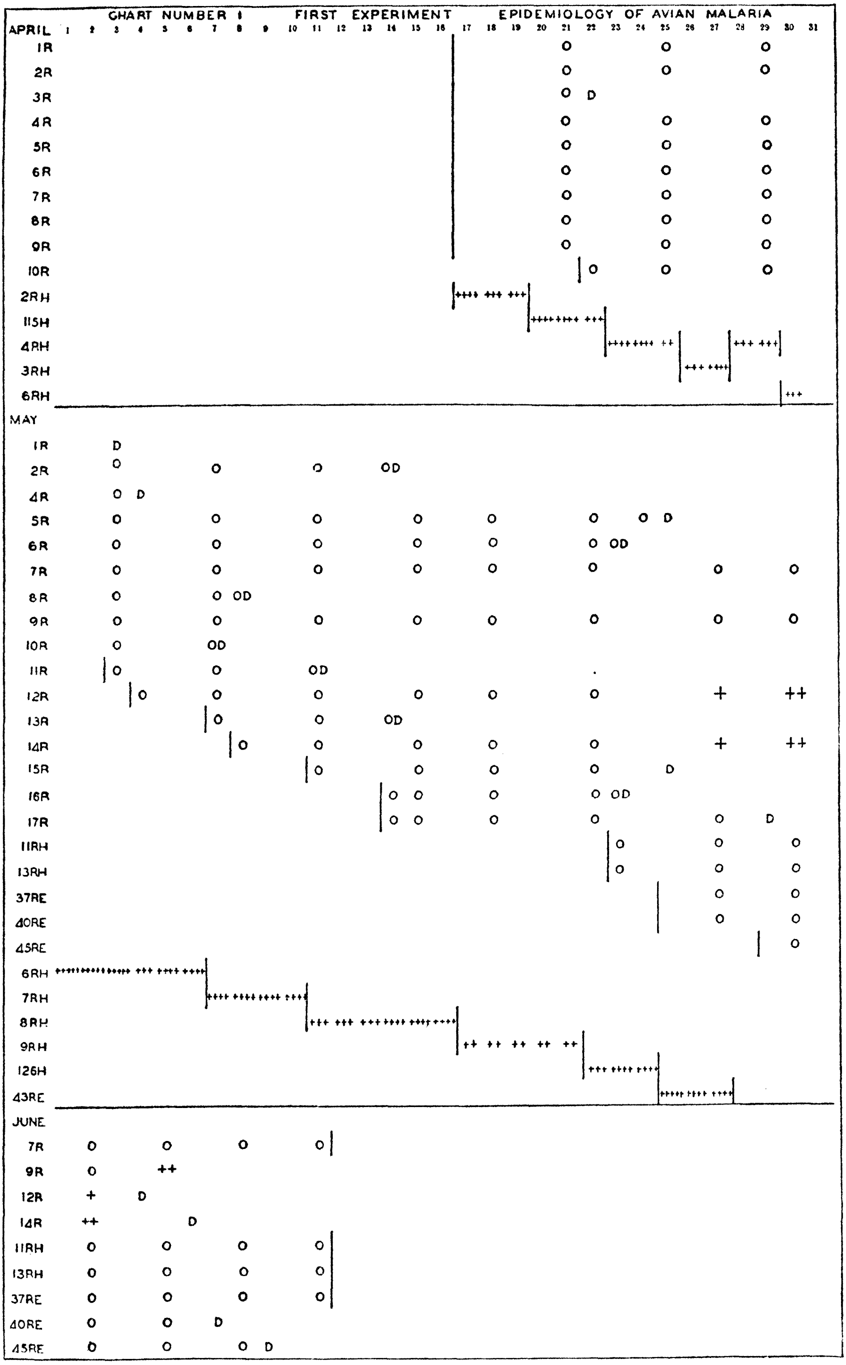

FIG. 1. Chart 1, first experiment, epidemiology of avian malaria.

July 14. Gametocyte carrier U30 substituted for U31.

July 22. Gametocyte carrier U2 substituted for U30.

July 24. X8 died with no evidence of malaria. This is the first bird to die in the cage since the beginning of the experiment. Gametocyte carrier U2 removed and not replaced.

July 28. X9 died with no evidence of malaria.

August 7. X2 died with no evidence of malaria.

August 12. Experiment discontinued. There has been no transmission of malaria whatever in this experiment, yet at all times there have been gametocytes available.

DISCUSSION OF SECOND EXPERIMENT

In order to test the susceptibility of the birds in this experiment X1, 3, 4, 5, 6, and 10 were inoculated by needle with the same strain of malaria plasmodium on dates as shown in fig. 2. Birds X3 and X10 died before becoming positive, four and two days, respectively, after inoculation. The other four birds became positive after the usual prepatent periods, showing that they were susceptible and proving that they had not previously been infected by the mosquitoes.

The same strain of mosquitoes was used in the third experiment (see below) and they were thereby also proved to be susceptible.

In this second experiment we therefore had a situation corresponding somewhat to anophelism sans malaria. The mosquitoes readily fed on the population and were not diverted to other animals, as is sometimes the case in nature where anophelism sans malaria exists. At all times 10 per cent (one bird) of the population carried gametocytes, yet malaria did not spread. There was too high mortality among the mosquitoes and there were too few gametocyte carriers. The mosquito turnover was much higher in this experiment than in the first.

The "epidemic potential" in this second experiment was not high enough. This term, "epidemic potential," was suggested by Peters,(160) whose book is not available to this author. Topley defines Peters's term as "the balance of interacting forces which tends towards the occurrence of an outbreak of disease." It is a good term to replace Sydenham's ill-defined "epidemic constitution," which seems to have been forced back into use by the last pandemic of influenza, an occurrence that was and is inexplicable in terms of modern epidemiology. "Epidemic potential," as a term, helps not at all toward fundamental explanations, yet it more aptly expresses the modern view.

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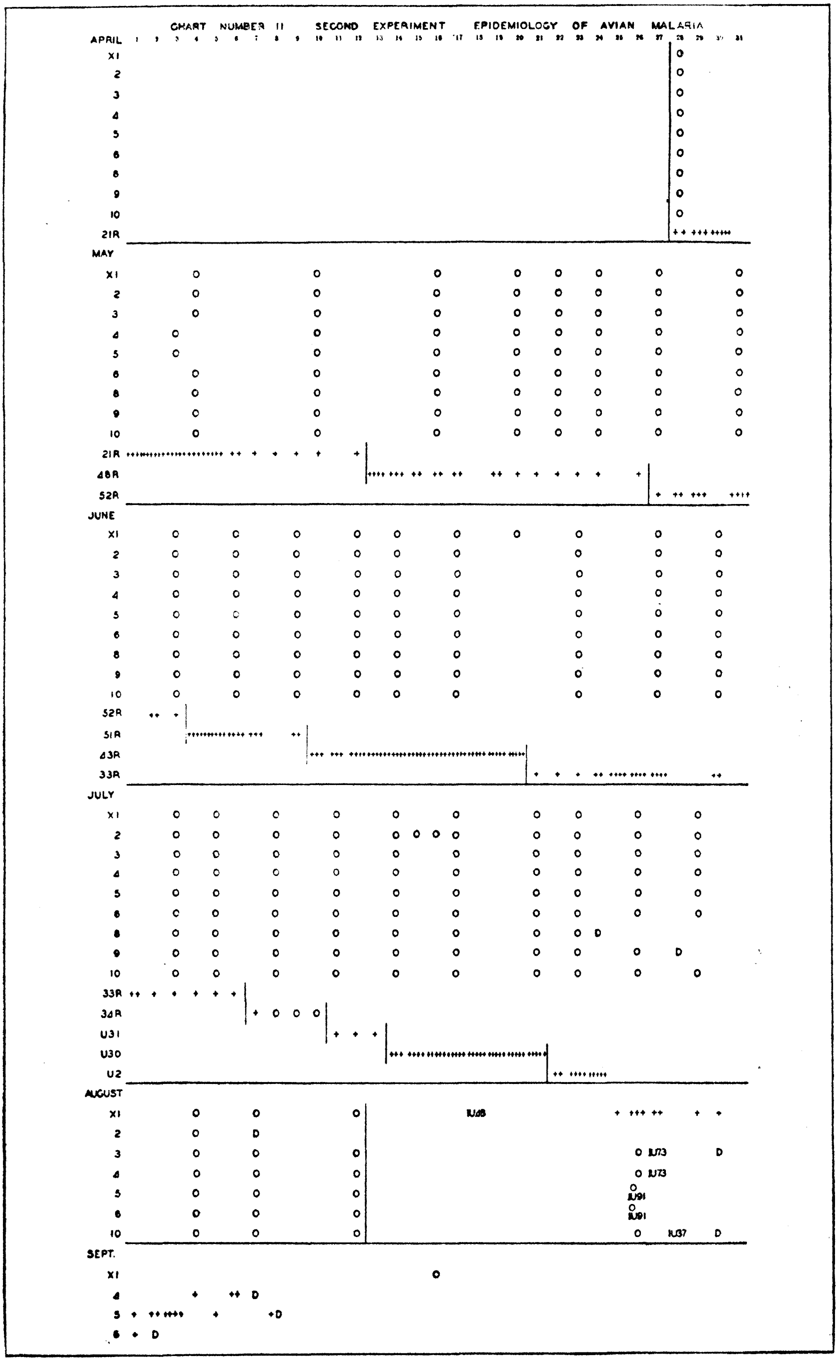

FIG. 2. Chart 2, second experiment, epidemiology of avian malaria.

THIRD EXPERIMENT

A colony of *C. quinquefasciatus* having established itself in a cage, the experiment was started.

August 14, 1930. Susceptible bird X13 put in cage with gametocyte carriers U36, U40, U41, and U42.

August 19. Gametocyte carriers U48 and U88 substituted for U41 and U42.

August 21. Gametocyte carriers U89 and U91 substituted for U40 and U48.

August 23. Gametocyte carrier U90 substituted for U36.

August 27. Gametocyte carriers U37 and U73 substituted for U88 and U89.

August 28. Gametocyte carriers U90 and U91 removed from cage.

August 29. Gametocyte carriers U22 and U38 put in cage.

September 2. Gametocyte carriers U68, U69, U72 substituted for U22, U37 and U73.

September 5. Gametocyte carriers U92, U93, and X12 substituted for U68, U69, and U92.

September 6. Gametocyte carrier U92 removed from cage.

September 8. Gametocyte carrier U84 put in cage.

September 9. Gametocyte carriers U78 and J17 substituted for U38 and X12.

September 11. Gametocyte carrier J18 substituted for U93.

September 12. Gametocyte carrier J22 substituted for U84.

September 13. Gametocyte carrier J40 substituted for J22.

September 15. Gametocyte carriers U80 anad J38 substituted for U78 and J40.

September 17. X13 has a positive blood smear. Experiment ended.

DISCUSSION OF THIRD EXPERIMENT

Here we had a condition simulating an area in which malaria is hyperendemic and into which a susceptible individual comes. Eighty per cent of the population carried gametocytes in their blood. There were mosquitoes in abundance. It was a foregone conclusion that the susceptible would become infected.

The mosquito turnover in this third experiment was comparable to that in the second where no transmission of malaria took place. But here the "epidemic potential" was high.

These first experiments are not to be analyzed too closely mathematically. It has been necessary to proceed slowly and to develop technical facility. This report is made as an introductory one because it seems to point towards an experimental procedure in the study of the epidemiology of malaria which may lead to a better understanding of fundamental relationships.

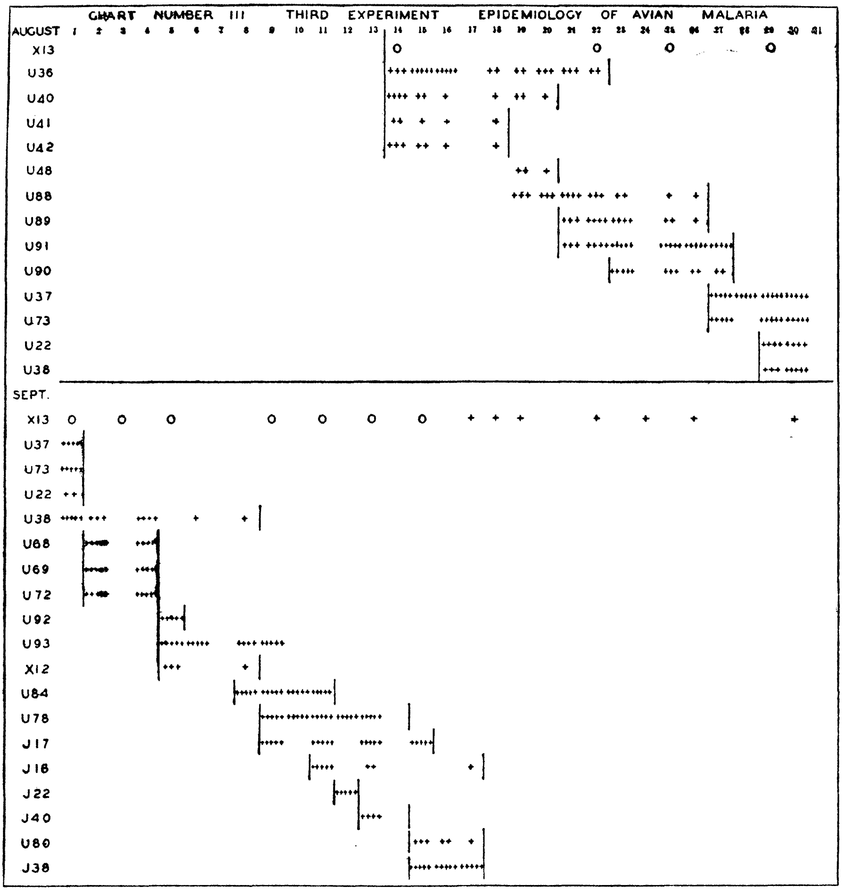

FIG. 8. Chart 3, third experiment, epidemiology of avian malaria.

SUMMARY

The subject of experimental epidemiology is briefly discussed with especial reference to malaria. Three preliminary experiments in the epidemiology of avian malaria are reported with a discussion of technic and results. A bibliography is appended.

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ILLUSTRATIONS

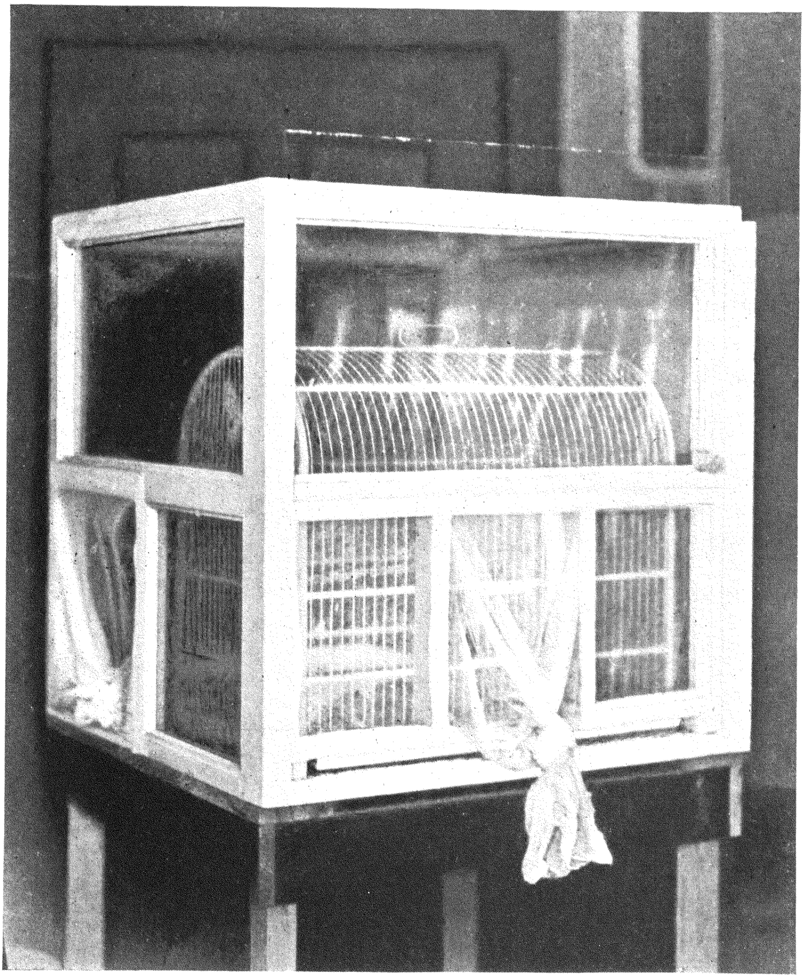
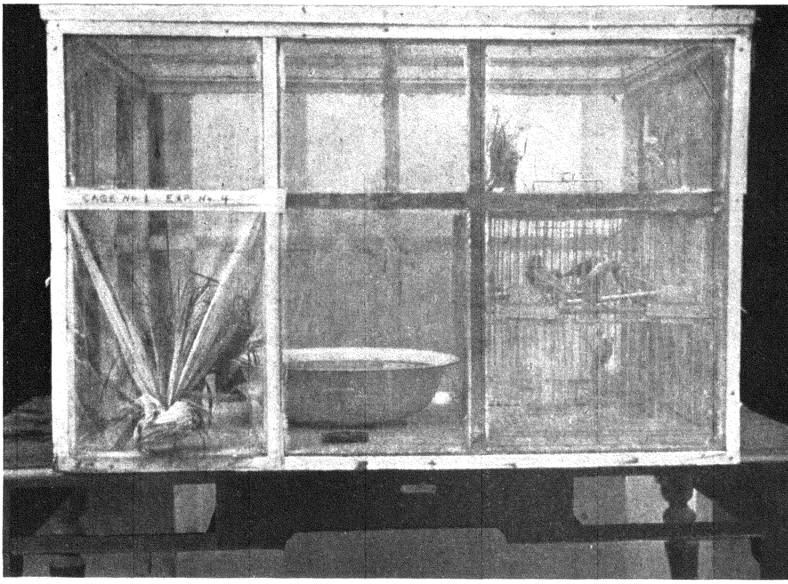


PLATE 1.



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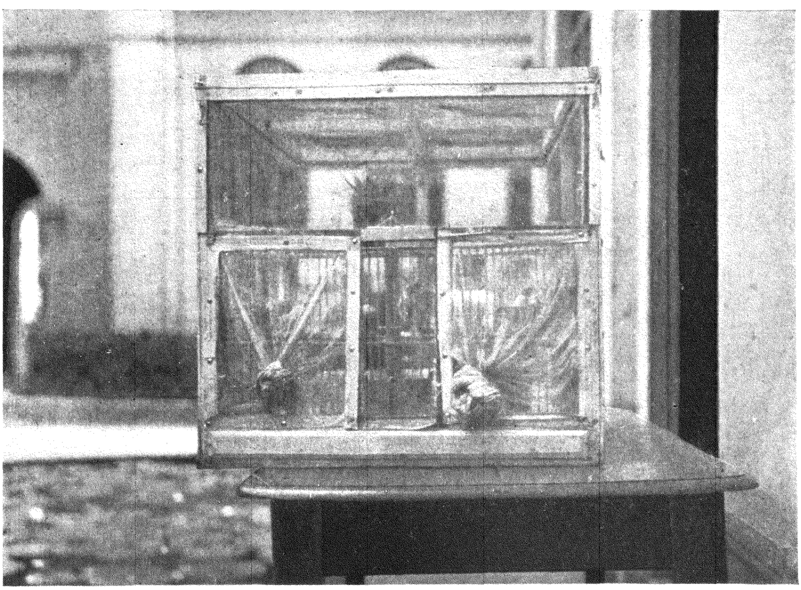

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PLATE 2.

BORED-HOLE LATRINE EQUIPMENT AND CONSTRUCTION [1]

By Clark H. Yeager

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SEVEN PLATES AND FORTY-SIX TEXT FIGURES

In response to numerous requests for descriptions of latrine-boring equipment, where it may be purchased, the cost, and how to use it, this article has been prepared.

The selection of the locations for bored-hole latrines should be under the direction of a person who has been instructed as to the possibility of pollution of domestic water supplies, especially the contamination of nearby shallow wells. Until more scientific data are available, the installation of bored latrines is suggested only for areas in which there is no danger of infecting the drinking water.

Satisfactory boring equipment that is cheap enough for wide distribution in poor communities is not yet made by any of the manufacturers, but an inexpensive satisfactory auger can be made by purchasing an auger bottom, and making the shaft and turning handle locally.

According to requests there seems to be need for an auger costing about 20 dollars United States currency that can be used universally and will work in water, soft sand, mud, clay, sea shells, ashes, and rock. We have not yet found a cheap auger that will work everywhere, and it is not likely that a single cheap auger can be made that will work in all the different formations. However, to be of practical value in most places the boring equipment must be the cheapest that will do the work. Many of the elaborate machine-driven rotary drills used in the oil fields and in some mining operations are too expensive and are not practical for boring latrines. In many places 90 per cent of the boring is in sandy clay or similar material, and only 10 per cent in soft sand requiring valve tools

[1]This work was done with the support and under the auspices of the Government of the Philippine Islands and the International Health Division of the Rockefeller Foundation.

or in other formations in which more-expensive equipment is needed. In such places it is a waste of money to purchase the more-expensive augers for the entire area, when cheaper augers will do 90 per cent of the work just as well and frequently better because of the design of the auger.

In a previous article an auger was suggested that will bore satisfactorily in most places, but this auger was not designed to cut through rock or to work in quicksand. Complaints stating that the auger failed in laterite, adobe rock, and sand have been received. We would not select an auger made for wood boring to cut a hole in marble or steel, and the selection of an auger is just as important in earth boring. The selection of boring tools depends upon the geological formation into which the hole is to be made.

Much of the equipment to be described can be made locally. It would require several volumes to cover the manufacturers' descriptions of the boring equipment on the market. I have not seen all of the augers manufactured, and very likely there are good tools that have not come to my attention, but the material included in this article will be sufficient for a selection of supplies that will be useful in making bored-hole latrines in a variety of formations. Much description that would not add greatly to the value of the article has been omitted.

The size of the holes to be bored is important in selecting equipment. Bored-hole latrines have been made from 10 to 24 inches in diameter, but 14- and 16-inch holes have been most frequently bored. There are some advantages in boring the holes only 12 inches in diameter, although there is more danger from fouling the sides and the capacity is more limited. It has not definitely been determined whether or not the 12-inch holes give the soil bacteria a better chance to work on the contents than in the larger holes. If the soil is porous the 12-inch holes could be used several years, especially with the water trap discussed under Construction.

If the walls of the hole cave in, a lining is required and this reduces the diameter of the 12-inch holes to about 10 inches, which is too small for practical use. An advantage of the 12-inch hole is that it is easier to bore than a 16-inch hole, and lighter and less-expensive equipment can be used. In some areas in the Philippines the 16-inch holes have been filled two-thirds full within fifteen months because coconut husks, sticks, and leaves were thrown into the hole instead of water or paper. Twelve-inch holes in these places would be filled in less than

a year. In many countries 14-inch augers are used, but fouling has been reported and in some of these places they have now changed to 15- or 16-inch augers. However, the 14-inch holes are satisfactory in many countries, and in the Philippines we have installed many 14-inch latrines. If the soil is likely to cave in we usually use a 16-inch auger because the bamboo lining reduces the diameter of the latrine to about 14 inches. In letters from manufacturers larger holes have been recommended in order to allow a man to go down to remove stones when necessary, but the employees in the Straits Settlements, Philippine Islands, and other countries have no trouble in going down a 16-inch hole. Fortunately bowlders are seldom encountered, except in some areas.

A 14-inch latrine would have to be bored to a depth of about 26 feet to have the same capacity as a 16-inch latrine 20 feet deep.

We generally speak of boring 14- or 16-inch holes with augers of these diameters, but in most soils the augers actually cut the holes an inch or two larger in diameter than the size of the auger.

The depth of the bored-hole latrine is from 12 to 26 feet. We stop at 12 feet only when deeper boring is difficult and expensive. The holes should average about 19 feet in depth, although we have made a number of school and public latrines 23 feet deep.

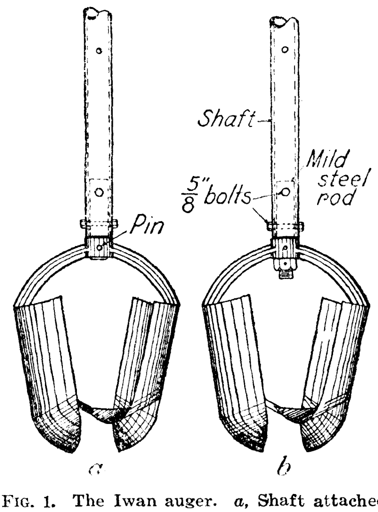

FIG. 1. The Iwan auger. *a*, Shaft attached to auger arch; *b*, a more solid joint with a nut below the socket. The bolts and nuts are not necessary if the shaft is welded to the arch.

THE IWAN POST-HOLE AUGER

The Iwan post-hole auger (fig. 1) is inexpensive and can be used for nearly all surface-soil borings where hardpan, rock, and quicksand are not encountered. The shaft of this auger supplied by the manufacturer is not as satisfactory as the shafts made locally; so we purchase only the "auger bottoms," as the manufacturer calls them, and make our own shafts. The auger bottoms consist of two cutting blades and an arch or

yoke to which the blades are riveted and to which the shaft can be attached. In order to save cost of transportation one shipment of auger blades and arches were ordered unassembled. We had the blades and arches welded and riveted together locally and the augers worked very well, but we did not save much money and had the additional trouble and loss of time. In following orders we always ordered the "auger bottoms" as advised by the manufacturer and not the blades and arches. The blades must be riveted in proper alignment or the auger will not bore a straight hole. Because of easier packing in standard cases we now order in lots of even dozens and not ten, sixteen, or thirty-eight auger bottoms for one shipment. The bottoms 16 inches in diameter cost 81.60 dollars United States currency a dozen. The 14-inch bottoms cost 67.20 dollars a dozen.

We have broken only two of the 1/8-inch blades on the standard Iwan augers in the Philippines; therefore, for general distribution we do not find the additional cost of heavier blades justified, but Dr. John F. Kendrick, in India, has not been so fortunate, and purchases especially heavy blades and makes the arches (yoke pieces) and shafts locally. Unusual soils require the heavy blades. Iwan Brothers, of South Bend, Indiana, make extra heavy 16-inch diameter auger blades of 3/16-inch steel in lots of ten pairs at 6 dollars United States currency per pair, f. o. b. cars, New York. The steel strap to bring the blade points together at the bottom is furnished by the manufacturer. The auger bottom, complete with arch and heavy blades riveted together, costs 12 dollars. The standard weight 16-inch augers cost 7.50 dollars each. The regular 14-inch augers cost 5.95 dollars each, and according to Mr. Rollin C. Dean, of the Rockefeller Foundation, the 14-inch augers with 3/16-inch blades would cost about 10.50 dollars each.

The shaft.—The 1-inch shaft supplied by the manufacturers of the Iwan augers is in short sections and has threaded joints. This type of shaft is satisfactory for the purpose originally intended as a post-hole auger, but for boring to a depth of about 19 feet a $1\frac{1}{2}$-inch shaft from 19 to 22 feet long is more satisfactory.

The auger bottom measures 19 inches from the tip of the blades to the top of the arch; therefore, a 20-foot shaft allows boring to a depth of about 20 feet. We usually use ordinary

water or gas pipe, plain or galvanized, which is shipped in lengths averaging over 19 feet. The longest lengths are selected because the auger is more easily turned if at least 2 feet of the shaft extends above the surface of the earth when the last few turns are being made.

In soft soil 1¼-inch pipe (inside diameter) for making shafts has given satisfactory service, but in most of the soil in the Philippine Islands it has been necessary to use 1½-inch pipe, and in one place in the Straits Settlements 2-inch steam pipe was used. In early trials the 1-inch and 1¼-inch shafts bent and broke, and a number of braces designed to keep the shaft from bending and boring at an angle were tried. These devices worked very well, but added to the expense, complicated the equipment, and required more time on account of lost motion in adjusting the shaft. Then shafts of larger diameter were used, and by selecting shafts large enough to suit the soil there was no further difficulty. Shafts that do not bend too much will bore straight holes unless a bowlder or other solid material causes deviation. A large shaft has a more even torque than a small one and will not break or bend enough to bore at an angle. Two- or 3-inch shafts can be used, but in most hard soil 1½-inch pipe serves the purpose.

In places where the ordinary 1¼-inch water-pipe shafts broke, steam pipe and boiler tubes were tried and not only extra thick but double extra heavy pipe was used, but these heavy pipes are usually not as satisfactory, considering cost and service rendered, as ordinary pipe of larger diameter. The strength for the money expended up to certain limits depends upon the diameter of the shaft. The torque of an ordinary 1½-inch water-pipe shaft is very much better than that of a solid bar or a smaller pipe of the same length and weight. In some countries the water pipe is of inferior quality and at times crushes or splits up the seam; in these instances, after the failure of 2-, 2½-, or 3-inch shafts, it might be necessary to use heavy or extra-heavy steam pipe.

The shaft auger-bottom joint.—The threaded shafts of the Iwan augers as supplied by the manufacturer are screwed into a socket in the auger arch. These are probably satisfactory for boring shallow holes for telegraph poles, but are not strong enough for most bored-hole latrine boring. A more satisfactory joint is shown in fig. 1, *a*. This joint is made by threading the

end of a piece of round bar steel and screwing the bar into the auger socket. A hole is drilled through the socket and bar and a tool-steel pin is inserted for additional strength. A bar 10 inches long and $1\frac{1}{2}$ inches in diameter is suitable for a $1\frac{1}{2}$-inch shaft. The shaft is fastened to the bar with two $\frac{5}{8}$-inch bolts or steel rivets, which are inserted through holes bored 4 inches apart in opposite directions through the shaft and bar. These joints are satisfactory in most soils, but we have broken the socket pins in four augers and twisted the auger bottom off in one instance. After repairing we had no further trouble. Since losing one twisted auger bottom under 18 feet of water we have had the joints made stronger by screwing a nut on the bar which extends through the socket in the arch (fig. 1, *b*). We have had only one socket pin break in forty-eight augers since using the nut and in this instance the shaft revolved freely in the socket, but the nut on the underside stopped the auger bottom from coming off. The auger struck rock and was suddenly stopped. The blades of the auger were bent, which shows the strength of the joint. In the Straits Settlements in one area we bolted iron plates to the shaft and arch to take the strain off the socket, but at that time we did not use the extra nut.

We are now making the joint by welding the socket, bar, and shaft together at a cost of 8 pesos less per auger than the cost of boring the holes and using bolts, pins, and the nut. We have never had a welded joint break.

Turning the auger.—A simple and cheap way to turn the auger is to hitch a rope around the shaft and use a bar of wood or metal as a lever, but in our experience we find turning handles designed for the purpose are more satisfactory. The Wilson wrench, one of the best on the market and commonly used by oil drillers, is an excellent device for turning, but these wrenches are comparatively expensive. A more satisfactory wrench for latrine boring and used by us in the Straits Settlements and the Philippine Islands costs 7.50 dollars complete and has many advantages. This wrench is made by bolting a handle made locally by a blacksmith to a $2\frac{1}{2}$-inch Vulcan bijaw or similar chain tong usually carried in stock by hardware dealers. The additional handle greatly facilitates turning, and by slipping a 4-foot length of pipe over each handle the leverage is greatly increased. This wrench can be readjusted to any position on the shaft without removing the chain, by a quarter

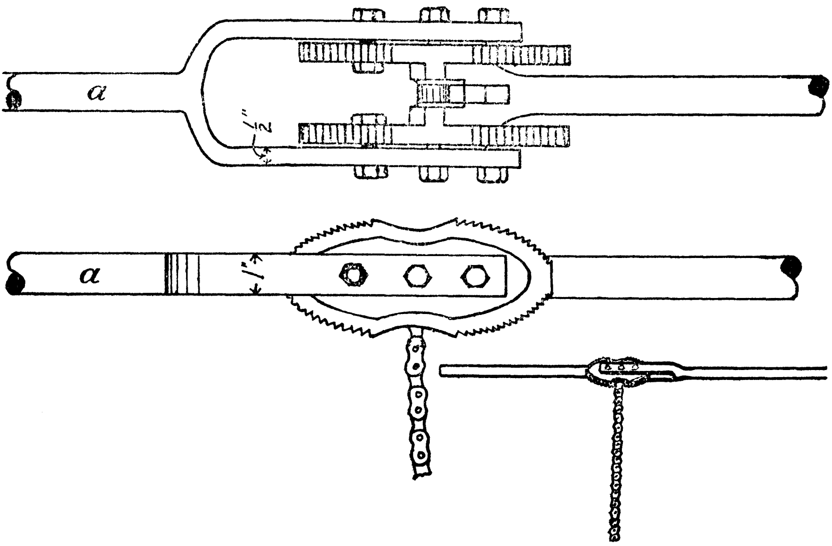

FIG. 2. The chain-tong turning handle, made by attaching the handle *a* to a Vulcan bijaw chain tong. This is an excellent turning device and has been used in many places.

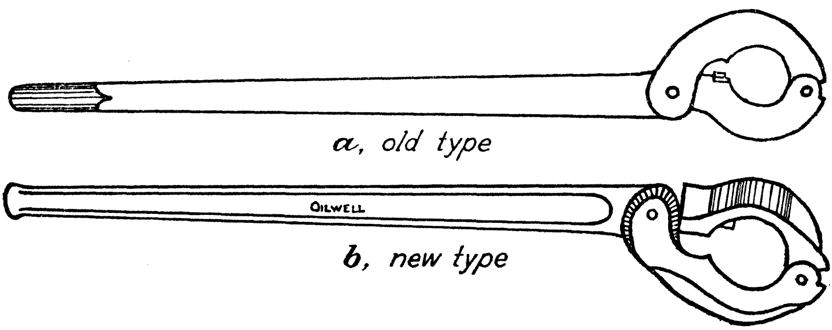

FIG. 3. Crumbie tongs, one of the most satisfactory inexpensive tongs on the market. *a*, Old type; *b*, improved Crumbie tongs; these cost a little more, but are worth it.

reverse turn and sliding the wrench up or down. Fig. 2 shows the simple construction of this wrench.

One of the most satisfactory and inexpensive wrenches is the Crumbie or the improved Crumbie wrench shown in fig. 3. This wrench does not damage the shaft and costs only about 3.50 dollars United States currency. An extension handle similar to the one shown on the Vulcan bijaw greatly improves the use of this wrench for boring. The National Supply Company and many other dealers carry these wrenches and the Vulcan bijaw in stock.

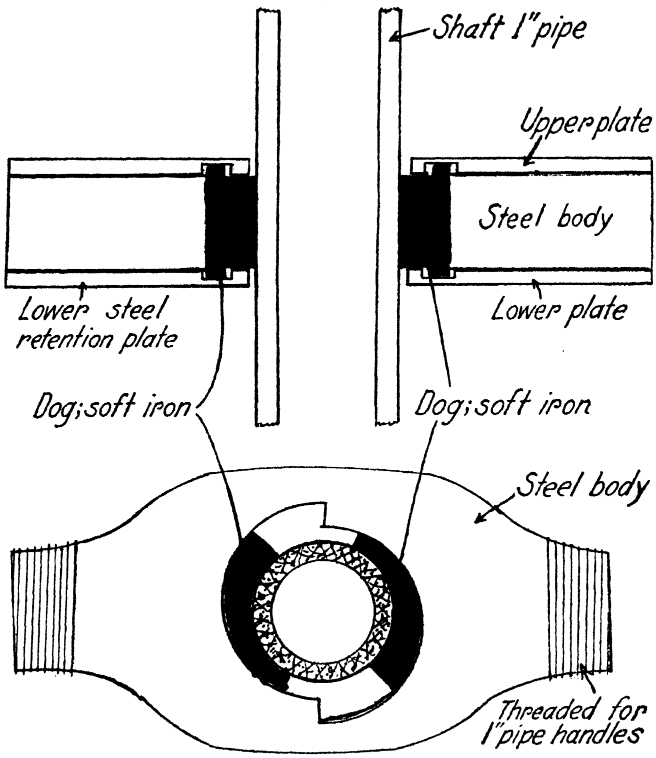

FIG. 4. Turning handle designed by Doctor Hamilton. "The two steel retention plates with the grooves on their inner surfaces serve to prevent the dogs from falling out of place when no pipe is between them. The plates are bolted together and to the frame of the body so that the dogs are easily removable and exchanged when worn or damaged."

Another wrench, shown in fig. 4, was designed by Dr. A. H. Hamilton in Java. He has this wrench made locally, but the cost, 40 pesos in the Philippines, is too high for general use.

Pipe-cross turning handles.—For economy and simplicity we designed the turning handles shown in fig. 5, *a*. We first used these handles in the Straits Settlements, and since making minor improvements we are using them on most of the augers in the Philippines. These handles are easy to assemble and can be made easily. A cross joint, or four-way water-pipe joint as it is sometimes called, large enough to slide up and down the shaft, two 4-foot pieces of pipe, and a $\frac{5}{8}$-inch chrome or tool-steel pin are all the parts needed. Since breaking a few of the light-weight crosses usually used for water pipe, we use heavier steam-pipe crosses. A hole is drilled through the center of the cross, through which the $\frac{5}{8}$-inch tool-steel pin can be

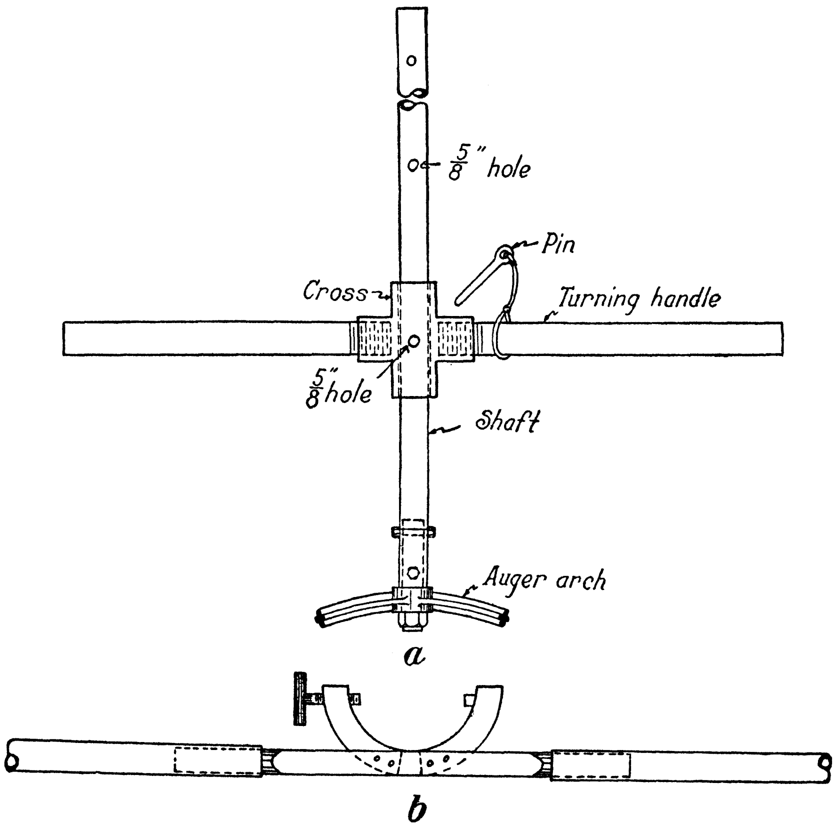

FIG. 5. Turning handles. *a,* The pipe-cross turning handle. This outfit is usually used in the Philippine Islands for general distribution because it is the least expensive satisfactory device we have tried. The only materials required are two pieces of pipe, a heavy cross or four-way joint and a tool-steel pin to transfix the cross and shaft. The cross slides easily up or down the shaft; *b,* a turning handle for use on a shaft drilled with holes to engage the lugs. This wrench is more expensive than the pipe-cross handle.

inserted. At times we ream out the cross to make it slide easily on the shaft. The shaft is drilled at 18-inch or 2-foot intervals so that the position of the cross can be changed when necessary. The two 4-foot pipes are screwed into the cross on opposite sides of the shaft and serve as levers for turning the auger.

The cost of this cross turning handle depends upon the cost of material and labor. In Manila the auger shaft drilled and welded to the auger bottom and the cross turning handle, complete with pin ready for use, costs 17.50 pesos delivered to our

storeroom. Another handle is shown in fig. 5, *b*. This handle hooks in a hole in one side of the shaft and a screw enters a hole on the opposite side. This handle costs double the price of the cross handle.

The coupled shaft.—Where the transportation of the 20-foot shaft is difficult, a coupled shaft made of two 11- or 12-foot pipes can be used. A strong joint that will not wabble can be made by riveting a round solid iron bar 12 inches long into the end of one section of the shaft, allowing 6 inches of the bar to extend out of the end as shown in fig. 6, *a*. The protruding bar and the end of the other section of the shaft can be drilled in opposite directions for the insertion of two $\frac{5}{8}$-inch bolts, which can be removed when transporting the auger. If only one cross turning handle is used the upper section of the shaft will have to be added every time a latrine reaches a depth of about 11 feet. This takes only a minute, but if a number of latrines are to be bored in one area it saves time to have two crosses, one below the bolts and one above the bolts on the shaft. The 4-foot handles can be unscrewed from the lower cross and screwed into the upper cross by hand when necessary to shift to the upper section of the shaft. Each cross allows the handles to be shifted 11 feet. Another method is to bolt six crosses permanently to the shaft at 3-foot intervals, then the handles can be screwed in each cross as the boring becomes deeper, without shifting the cross. Our workmen prefer shifting the cross, and six crosses increase the cost; therefore, we use only one or two crosses.

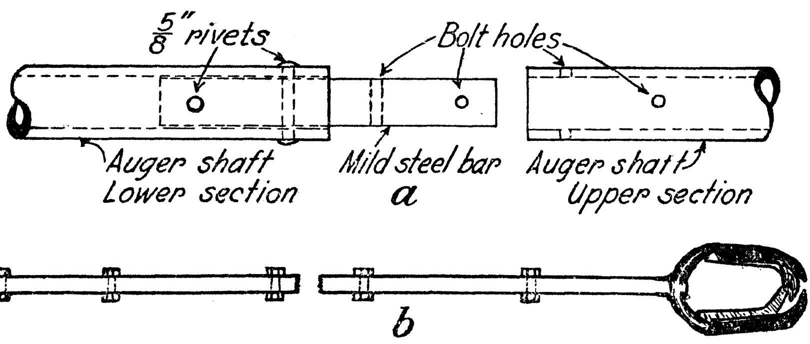

FIG. 6. Coupling and shaft. *a*, A solid coupling for shafts made in sections; two bolts are removed to take the shaft apart; *b*, the bolt shaft, one of the most useful shafts we have used. This shaft stands more rough use than any other shaft tried. Permanent bolts or rivets transfix the shaft at 3-foot intervals. The turning handles never damage this shaft. The bolt heads act as lugs for the handles to push against.

The bolt shaft and turning handles.—This method of turning is simple to use, fool proof, and easy to make. The bolt shaft shown in fig. 6, *b*, is made by inserting a series of pins or bolts through the shaft at 2-foot intervals, allowing the head of the bolt and nut to serve as lugs. If the bolts are too long cut them off flush with the nut. The nuts on the bolts are screwed against the shaft tightly and are never removed. The heads of the bolts and the nuts serve as lugs for the turning handle to push against to prevent the handle slipping around the shaft, and does away with the use of expensive chain tongs and wrenches, which damage the shaft to some extent. The turning handle is made from an iron bar, which is shaped so that it will hook on the nut on one side of the shaft and push on the bolt head on the opposite side and can be quickly attached for turning. Two different turning handles are shown in fig. 7, *a* and *b*. This device is a great time saver as there are no clamps, chains, screws, pins, or ropes to adjust. In one instance the shaft of an auger equipped with the cross turning

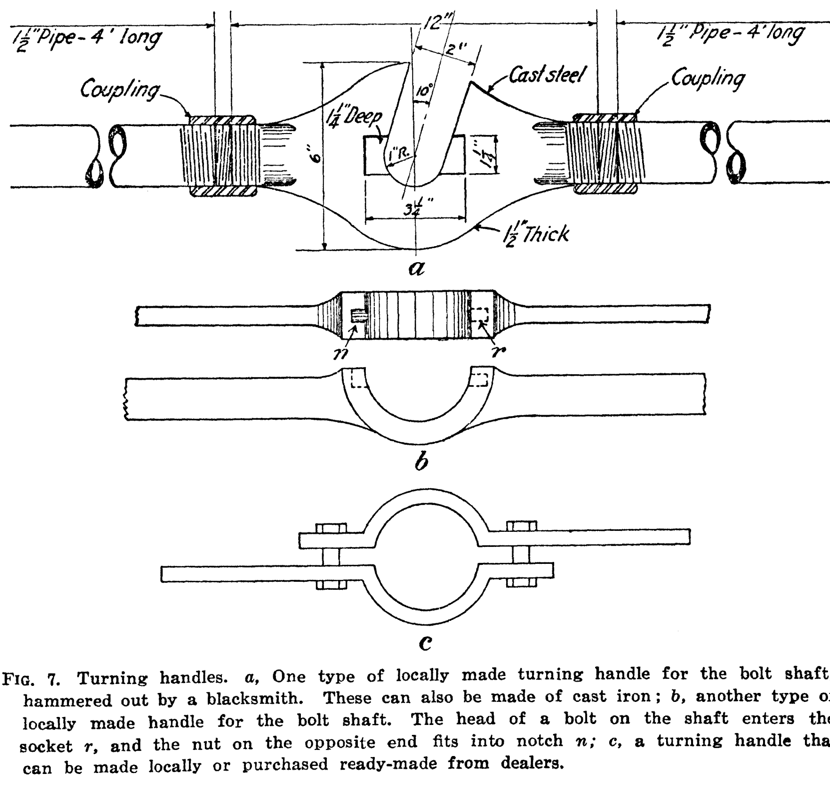

FIG. 7. Turning handles. *a*, One type of locally made turning handle for the bolt shaft, hammered out by a blacksmith. These can also be made of cast iron; *b*, another type of locally made handle for the bolt shaft. The head of a bolt on the shaft enters the socket *r*, and the nut on the opposite end fits into notch *n*; *c*, a turning handle that can be made locally or purchased ready-made from dealers.

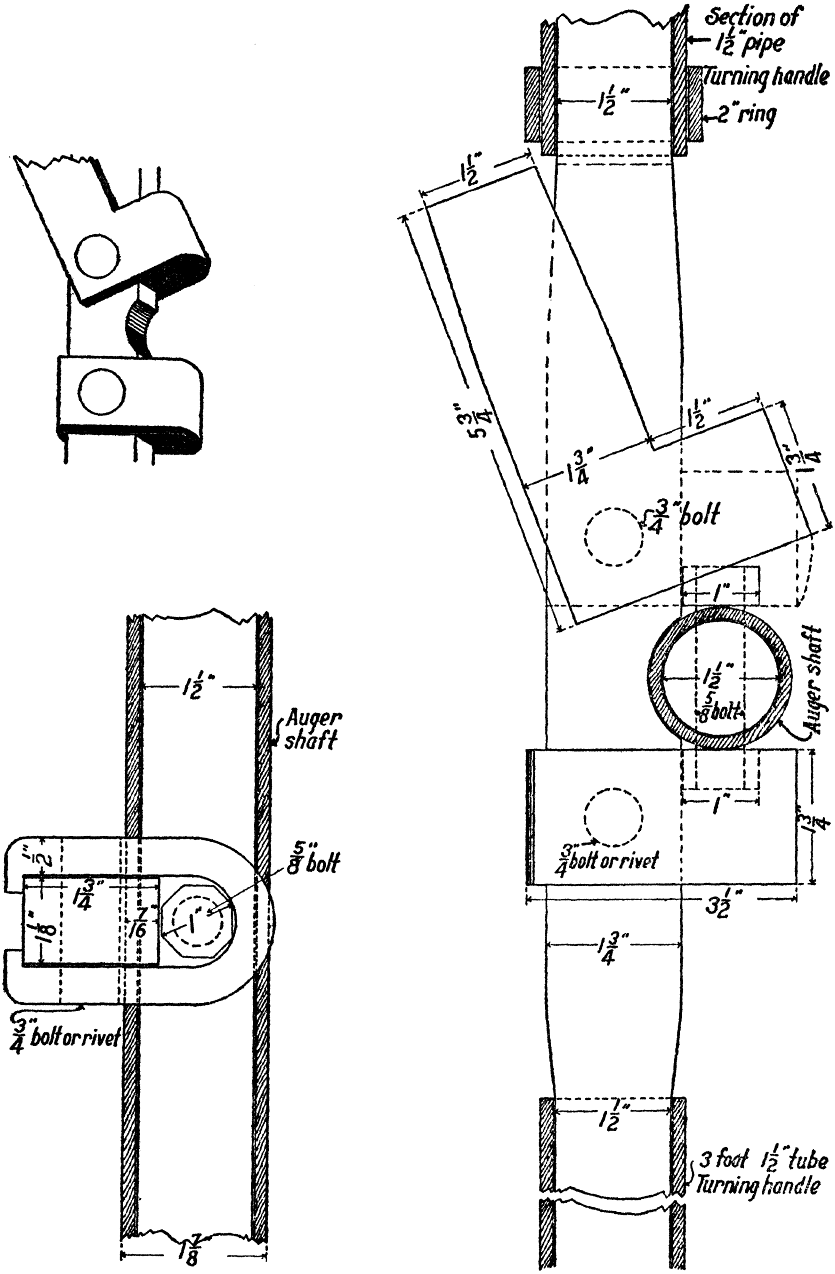

FIG. 8. A more elaborate turning handle for use on the bolt shaft. This is an excellent handle but costs 20 pesos to make locally. In large quantities the cost would be less.

handle was damaged so that the cross would not slide up the shaft, but the permanently bolted shaft stands a great deal of damage before it is put out of use. If the projecting bolts are objectionable, one bolt can be used and shifted from hole to hole when necessary to change the position of the handle. The series of permanent bolts are suggested in order to save time. The handle shown in fig. 7, *c*, is useful if rivets are used instead of bolts to prevent slipping. A more elaborate wrench, shown in fig. 8, has no damaging teeth and can be made locally. There are many excellent ready-made wrenches that can be purchased from dealers, but these are more expensive.

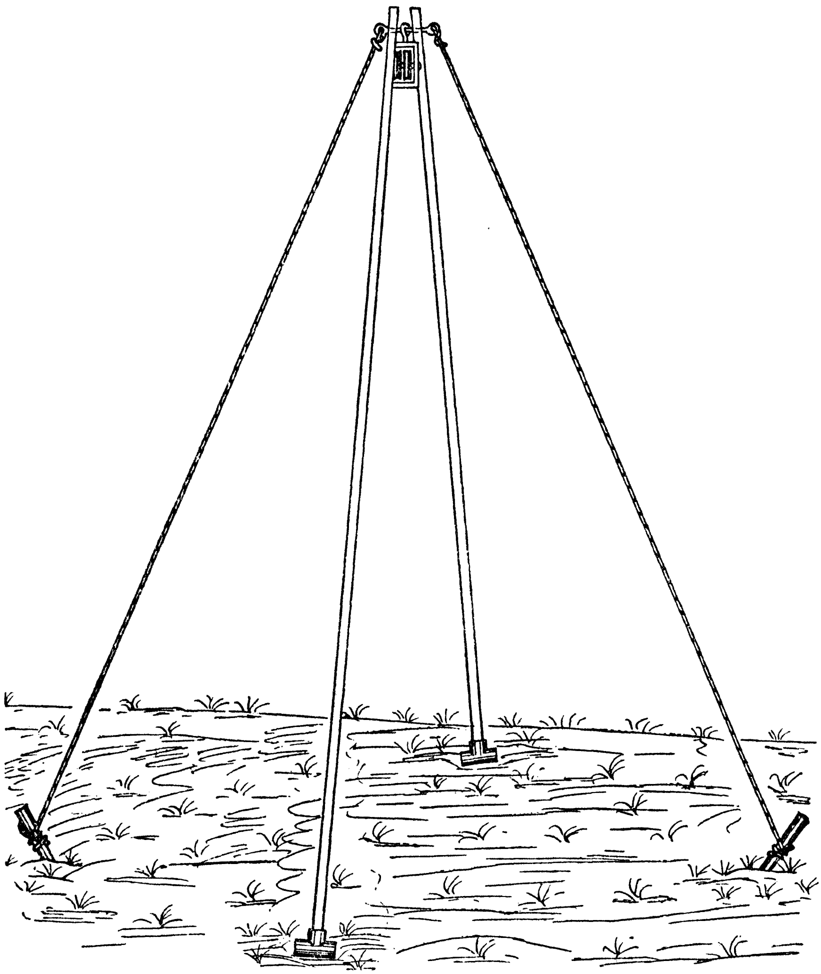

FIG. 9. The A frame now used instead of a tripod for hoisting augers. The guy ropes are usually tied to a house, tree, or fence post. Bamboo is usually used because it is much cheaper in the Philippines than iron pipe.

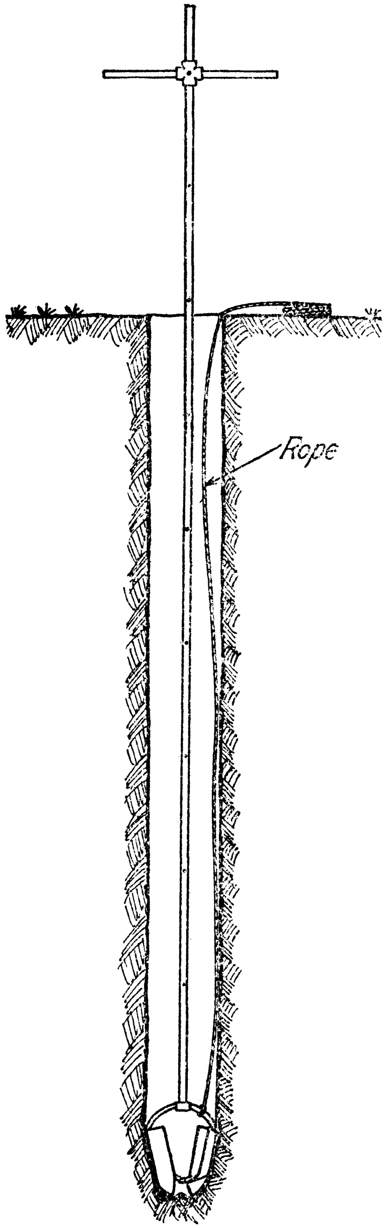

FIG. 10. In some places augers are lifted by direct pull, but the job is too heavy in most areas. The rope is attached to the arch or low down on the shaft.

HOISTING DEVICES

Tripods.—A tripod 25 feet in length made of bamboo or other wood or 2-inch water pipe is very useful for hoisting the auger by means of a pulley and rope.

Inverted V- or A-shaped frames.—For the past two years we have discontinued the use of tripods and now use only two poles or pipes supported by two guy ropes (fig. 9). The A frame is easier to transport and erect than a tripod and can be put up in places where there is not enough space for a tripod. The guy ropes can be attached to a house, trees, posts, or stakes driven into the earth. In some localities we get the bamboo poles for nothing, and in other places the bamboo costs 3 pesos or more. Bamboo breaks after using it a few times, and in places where it cannot be obtained or is expensive we make an inverted V frame from two $1\frac{1}{2}$-or 2-inch pipes fastened at the top with an iron bolt. The feet of this A frame are two T joints screwed on the ends of the legs. The T joints prevent the ends of the pipe from sinking into the earth. A stick or bar can be inserted into the T to prevent sinking in very soft soil.

Pulleys.—We have used a number of 12-inch well pulleys or gin

blocks for hoisting, but now use 4- to 7-inch compound pulleys of wood or metal. We usually use a double 6-inch pulley at the top of the frame and a single 4- or 6-inch pulley to attach to the auger. Compound pulleys are so well known that a description is not needed in this article.

If the soil and auger is not too heavy a tripod or hoisting frame is not necessary and the auger can be lifted by a direct pull on the rope attached to the arch of the auger as shown in fig. 10. It is difficult to start lifting an auger full of earth, but when once loosened it is easy to pull to the surface. The initial lift can be done by direct pull on the turning levers or by placing a plank or two across the mouth of the hole and applying leverage. Planks can be placed across the mouth of the hole and be notched so that they will support the shaft while turning.

The direct-pull method is too heavy in most areas in the Philippines, where we have even stopped using single pulleys and use compound pulleys. Dr. John L. Hydrick states that the direct-pull method is used successfully in Java and there is no tripod to transport.

Shaft support.—Latrines can be bored with only an auger, pulleys, and a tripod, but there is a great saving of energy if some kind of brace is used for the shaft of the auger. The most satisfactory cheap support we have used is a pair of doors, which cost 3 dollars United States currency, including material and labor. The doors are put in place as soon as the latrine is bored to a depth of about 2 feet. The doors are closed over the hole when the auger is lowered, and opened when the auger is raised. The doors are hinged to a wooden frame about 36 inches square, and the shaft of the auger turns in a hole cut in the closing edges of the doors (fig. 11).

Another type of brace that is cheap and satisfactory is shown in fig. 12, *a*. This brace is fastened to the frame about 5½ feet above the surface of the earth. A tipping auger can be lifted and emptied into a receptacle over the latrine, or a knock on the clamp of the brace will release the shaft, allowing the auger to be swung away from the hole to be emptied.

An excellent brace designed by Doctor Hamilton in Java is shown in fig. 13. This brace should hold the shaft steady, but the cost of making is too great for general distribution in the Philippines.

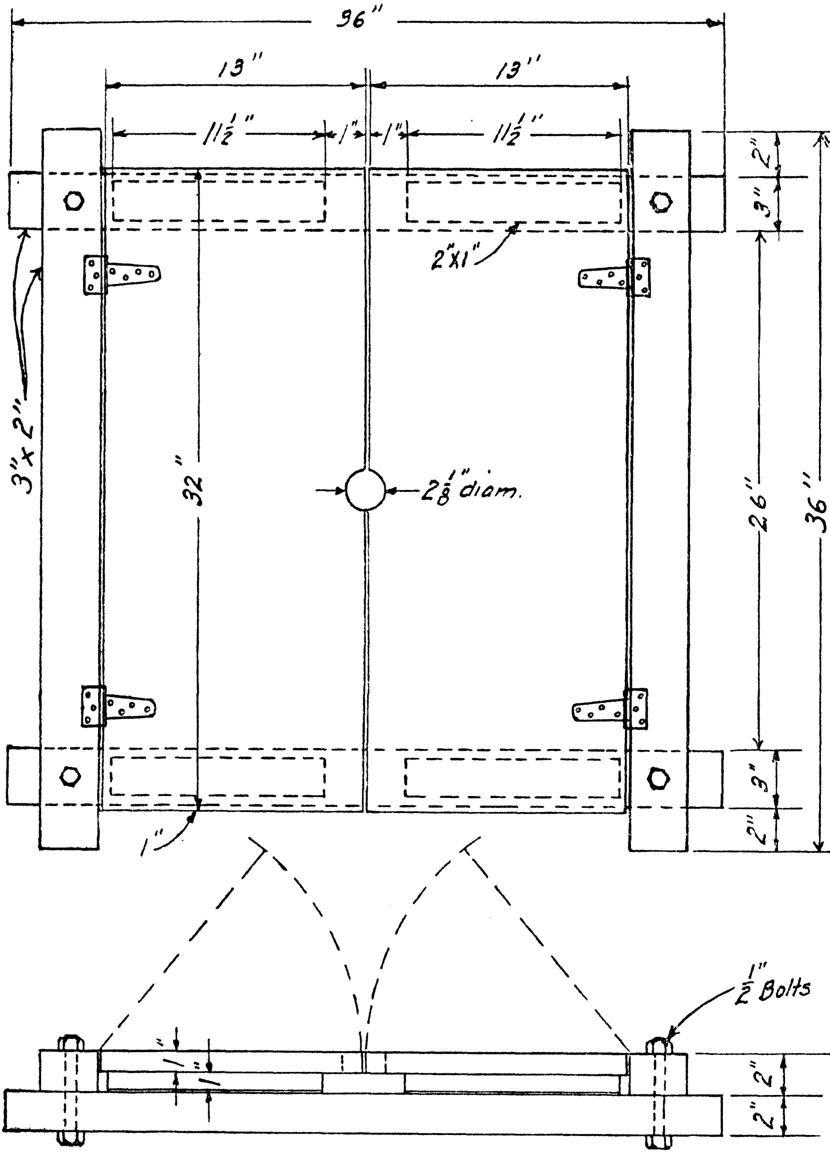

FIG. 11. Trap doors costing 6 pesos greatly facilitate boring. The auger shaft is supported by the doors when closed. Stakes can be driven into the earth at the notched corners to prevent movement of the platform while turning. One of these platform braces is now included as standard equipment with every auger used in the Philippines.

A quadruple brace sold by the Alsdorf Corporation is shown in fig. 14.

Accessories.—A bamboo pole or tamping rod is used in some kinds of soil, especially certain kinds of sands, to tamp the earth

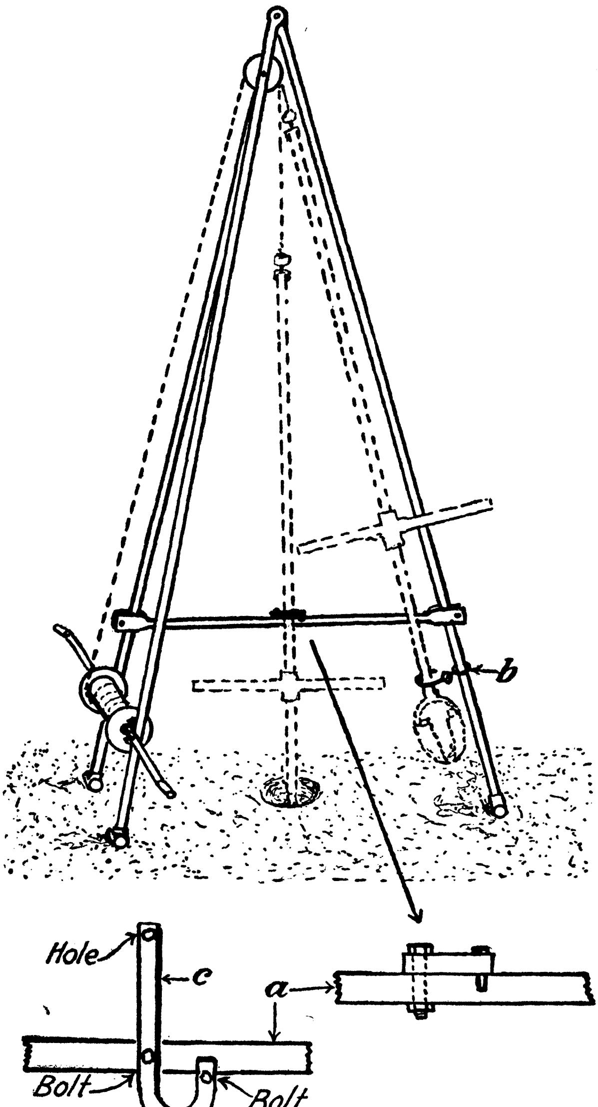

FIG. 12. This tripod is more difficult to transport than the A frames, but if properly made greatly speeds up boring when several holes are to be bored within a small area. *a*, Shaft support. A knock on the extension lever *c* releases the auger so that it can be swung away to be emptied; *b*, an iron hook that is a great time and energy saver. These hooks hold the auger away from the latrine while being emptied. The hooks are also used on A frames.

more solidly in the auger to prevent it from falling out when lifted. A little clay can be thrown down the hole in some places to make the earth more cohesive. Clay is sometimes used in

well drilling in very soft earth to prevent temporarily the sides from caving.

A long piece of 1- or $1\frac{1}{4}$-inch iron pipe with a tool-steel chisel riveted or welded into one end is useful for breaking hard strata or straightening the sides of the hole. Ordinary straight chisels, the T, or cross chisels, can be used.

An inexpensive swivel to prevent the ropes twisting can be used on top of the auger shaft, but this requires a high A frame. A swivel that will screw on the end of the shaft is made from an ordinary cap and iron ring as shown in fig. 15. Even a 15-foot A frame

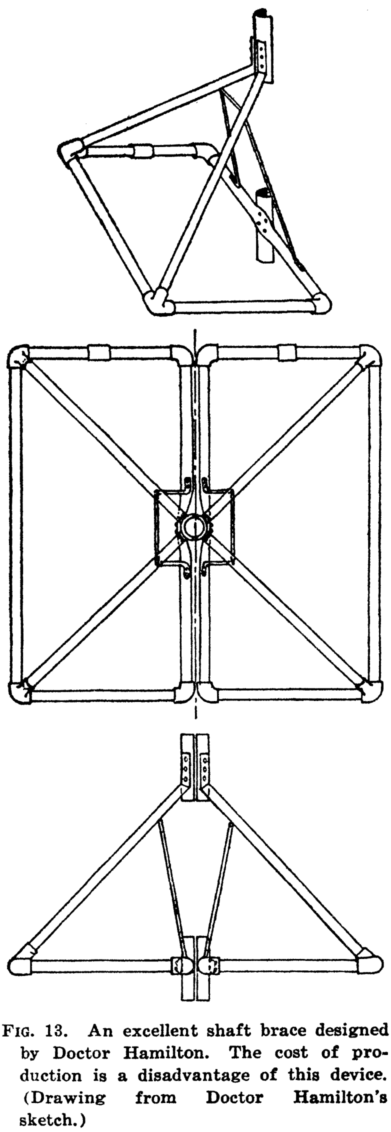

FIG. 13. An excellent shaft brace designed by Doctor Hamilton. The cost of production is a disadvantage of this device. (Drawing from Doctor Hamilton's sketch.)

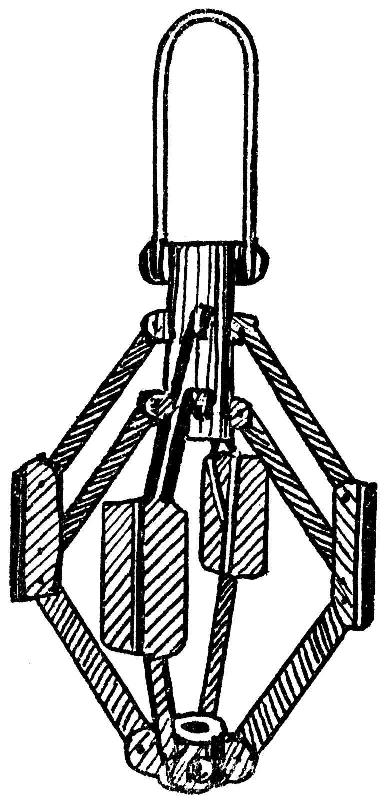

FIG. 14. A quadruple expansion brace sold by the Alsdorf Corporation. The stock size is made to fit the Standard earth auger.

can be used, if a removable turning handle is used and no swivel, by hooking the lower pulley of the tackle to a movable iron ring on the shaft. We usually use a 25-foot A frame for greater convenience, and on augers equipped with the cross turning handles, which are not removed when hoisting, we provide an iron ring that can be shifted and costs 40 cents at a ship chandlery or hardware store. The bolt of this ring is slipped into one of the easily reached holes of the shaft, and the tackle is hooked on each time before lifting. It is unhooked when turning the auger to prevent twisting. Devices for hooking the tackle to the shaft are shown in fig. 16.

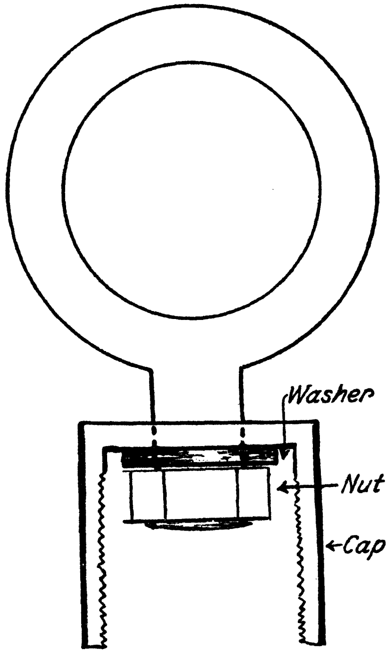

FIG. 15. A locally made swivel for use on the top of the shaft. We have used these swivels but prefer unhooking the rope from the shaft while turning the auger.

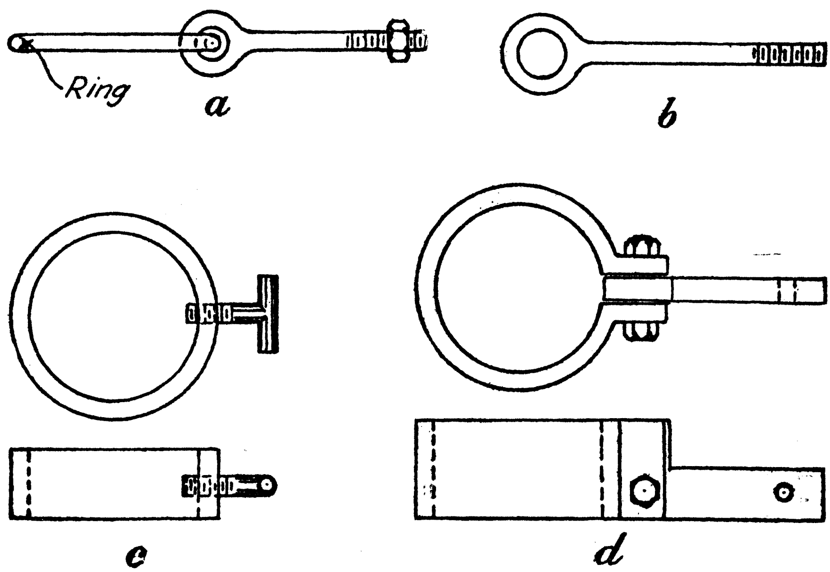

FIG. 16. Devices which can be attached to the auger shaft and adjusted to any position so that a hook on the hoisting rope can be quickly hooked on instead of tying and undoing knots; *a* and *b* are used on shafts with holes drilled at intervals such as used with the pipe-cross handles; *c* and *d* are used on the plain or bolt shafts.

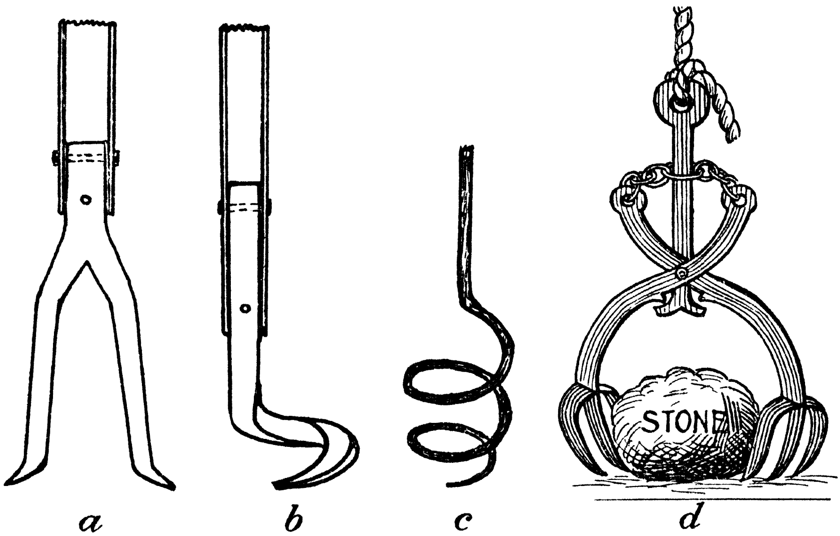

FIG. 17. Reamer, stone hooks, and grapple. *a*, An undercutting reamer which is useful in cutting away the sides of latrines below linings; fortunately it is rarely necessary to use one of these; *b* and *c*, stone hooks which are useful in removing small bowlders; *d*, a grapple (redrawn from picture from R. R. Howell & Co.).

We find an iron hook (fig. 12, *b*) attached to a leg of the A frame very useful to hold the auger away from the latrine when emptying. This saves energy because a man does not have to hold the auger for another man to empty.

The stone hooks and grapple shown in fig. 17, *b*, *c*, and *d*, are useful for hooking and pulling large stones out of the latrine.

The undercutter or reamer (fig. 17, *a*) is useful for cutting away the sides of the latrines below linings to facilitate sinking cylinders.

A cheap boring equipment for regularly hired squads.—The apparatus shown in fig. 12, while probably too expensive for general distribution, greatly facilitates rapid boring for the use

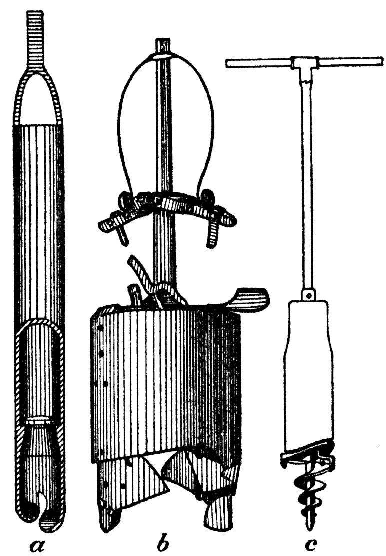

FIG. 18. Augers suitable for soft mud and silting sand. *a*, Type made by many manufacturers of drilling equipment; *b*, a heavy dumping auger such as used with machine-driven outfits; this auger is made by the Gus Pech Co.; *c*, the Lang auger with sand-boring screw; this is a good hand auger for boring in sand. See fig. 31, Howell drop-bottom auger.

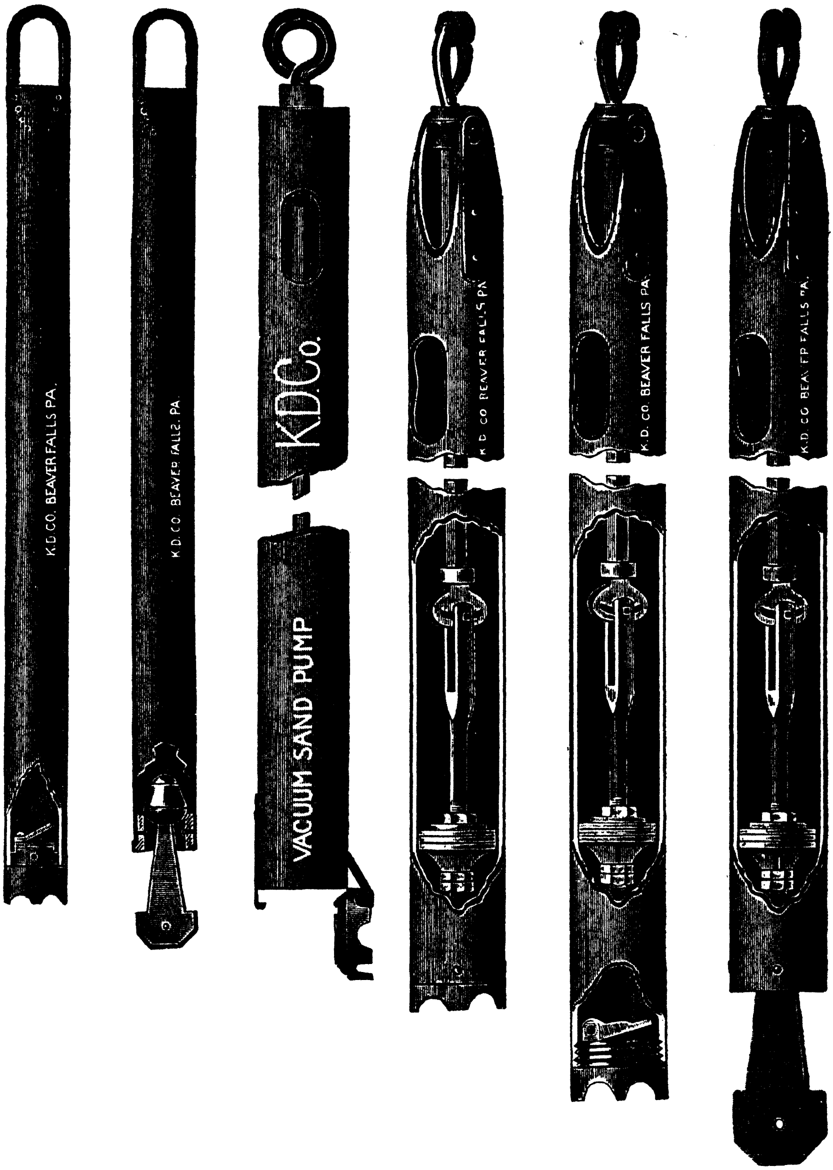

FIG. 19. Sand pumps and bailers which can be purchased from dealers. These pictures are from the Keystone Drilling Co., Beaver Falls, Pa.

of a squad of regularly hired men. Four men can work faster with this outfit than any other equipment we know of at the price. It will be noted that two legs of the tripod are close together to allow use in limited space, and to furnish extra support where there is the greatest strain. The tripod is made

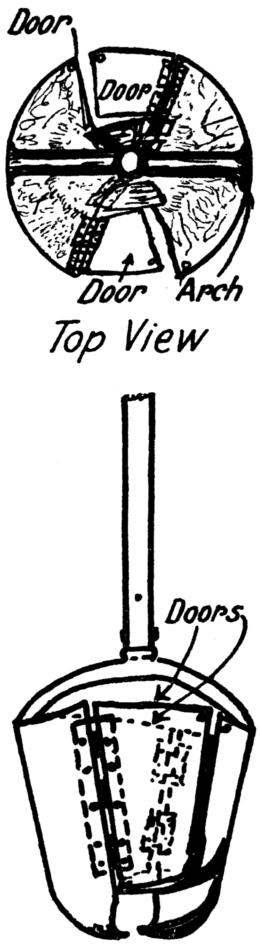

FIG. 20. The Iwan post-hole auger fitted with valves for use in silting sand.

locally of 2-inch water pipe. The cost of the equipment in Manila is 54 dollars for the tripod complete with winding drum and auger brace, not including the auger. This apparatus is more difficult to transport than the A-frame outfits.

Boring soft sand and mud.—These materials can be forced out with a pump, but it is not as satisfactory in routine work as an auger especially designed to do the work. A number of excellent sand bailers and augers sold by dealers are shown in figs. 18 and 19. Some of these work by a pounding motion, percussion, or spudding, and others work by rotation. Those shown in fig. 19 are not very useful in latrine installation. An excellent cheap rotating sand auger can be made by adding valves, or what might be called trap doors, to the ordinary Iwan post-hole auger. These doors are shown in fig. 20. Soft sand falls out of the sides of this auger as sent out by the manufacturer, but a piece of sheet metal hinged to the noncutting sides of this auger so that it will open about 2 inches, allowing sand to enter but not to fall out, serves the purpose in some places. Exceptionally soft sand will fall out of the bottom even when fitted with side valves, and in these places two additional doors should be fastened to the blunt edges of the blades crossing the bottom of the auger. The auger altered in this fashion does the work but is not as satisfactory as augers especially designed for silting soil. In order to empty this auger the shaft must be lowered almost horizontally, or a tipping hinge on the shaft can be made like those shown in figs. 21 to 23, which are made locally for use in the Philippines. These hinges always stop on a dead center, allowing the locking pin to be inserted quickly. A tap with a hammer or block of wood knocks the pin out when necessary. To facilitate transportation the

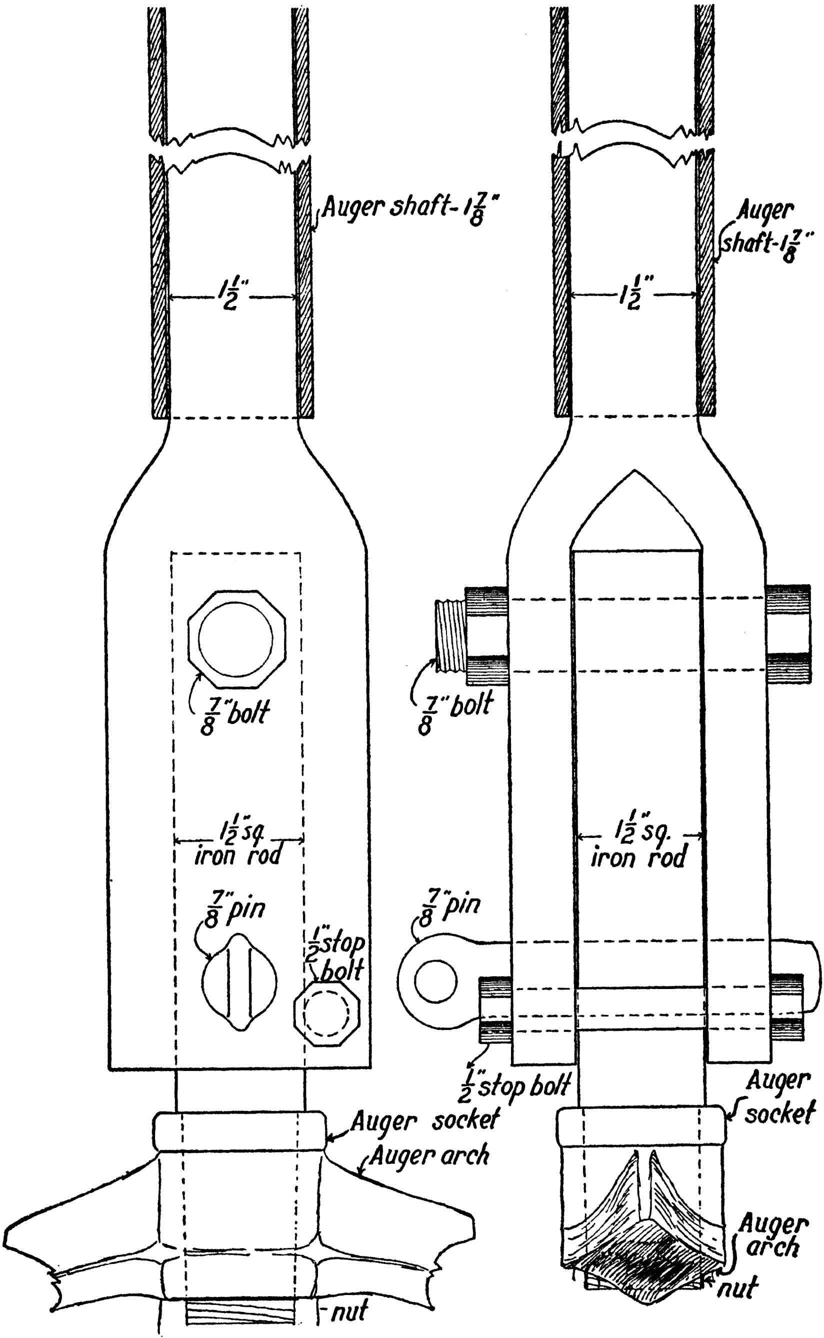

FIG. 21. A hinge to facilitate turning an auger over so that it can be dumped.

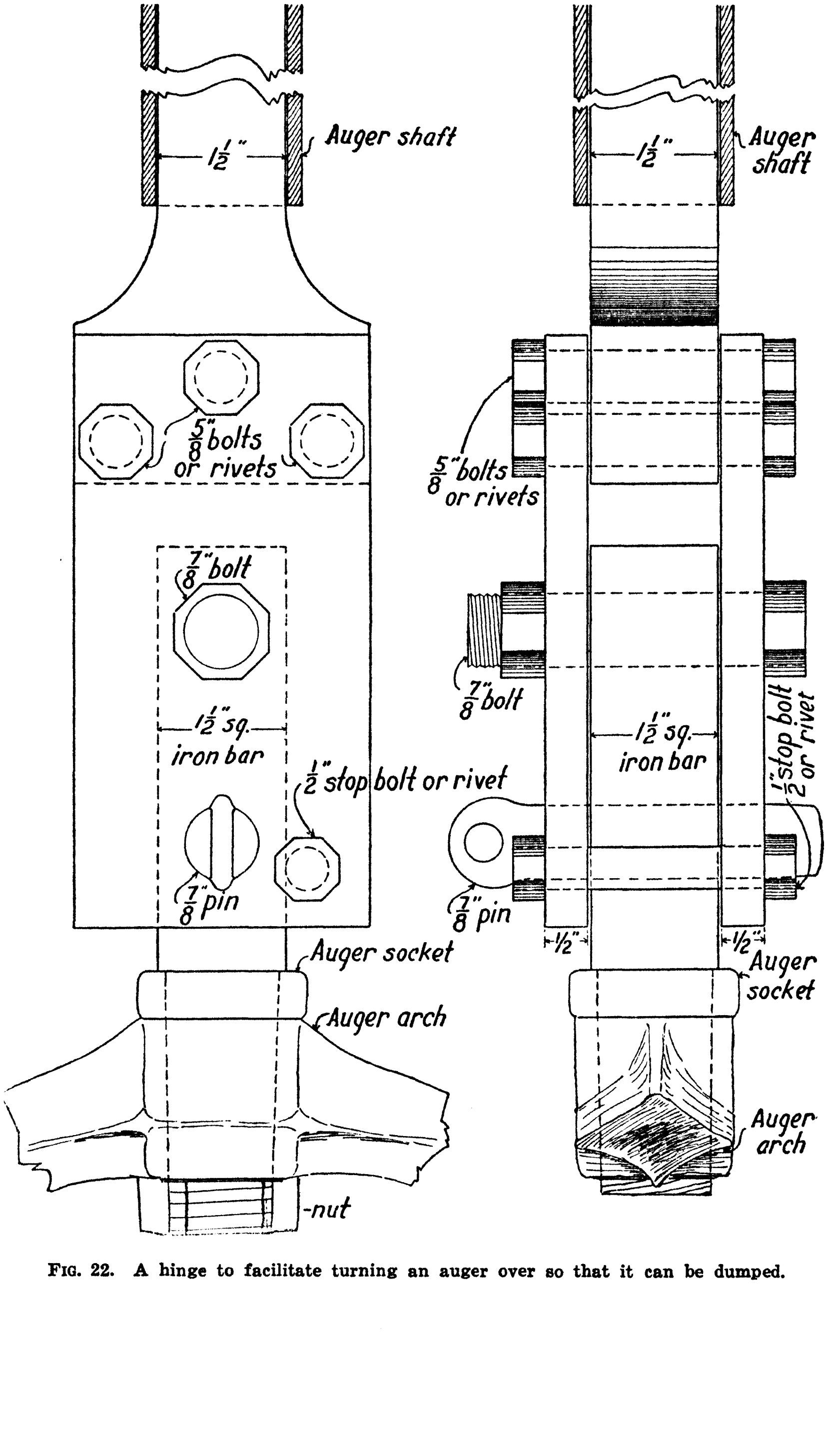

FIG. 22. A hinge to facilitate turning an auger over so that it can be dumped.

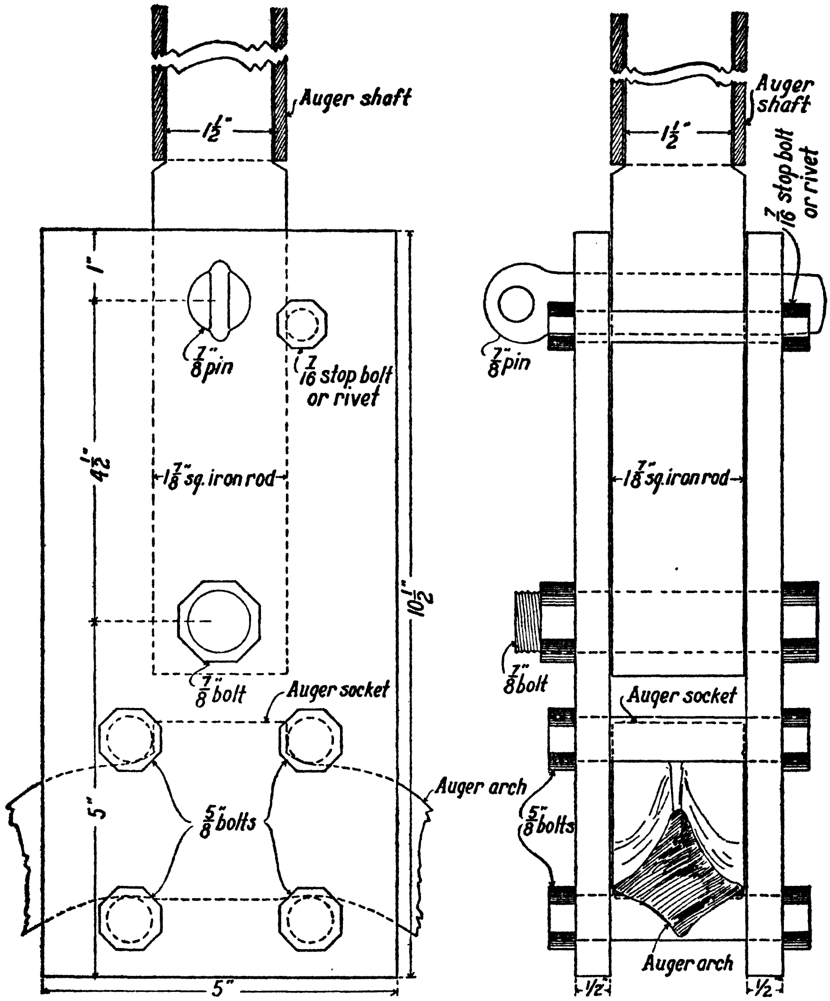

FIG. 23. A hinge for the same purpose as those shown in figs. 21 and 22.

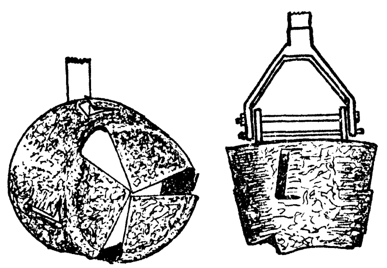

FIG. 24. An auger designed by A. L. Savignac for the United Fruit Co. This auger works in soft mud. Note the hinge for dumping.

auger bottom can be removed from the shaft by taking out the main bolt. Another type of hinge, used on an auger designed by Mr. A. L. Savignac for the United Fruit Company, is shown in fig. 24.

An excellent auger can be made locally as shown by fig. 25. The blades of this auger can be

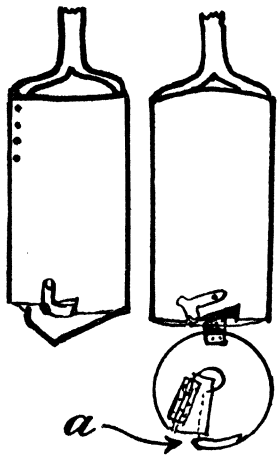

FIG. 25. A clay and sand auger that can be made locally. Augers of similar design are sold by many manufacturers without the flap valve *a*. R. R. Howell & Co., Minneapolis, manufacture these augers. A hinge on the shaft is not needed because the bottom of the auger swings back on a hinge to empty the contents.

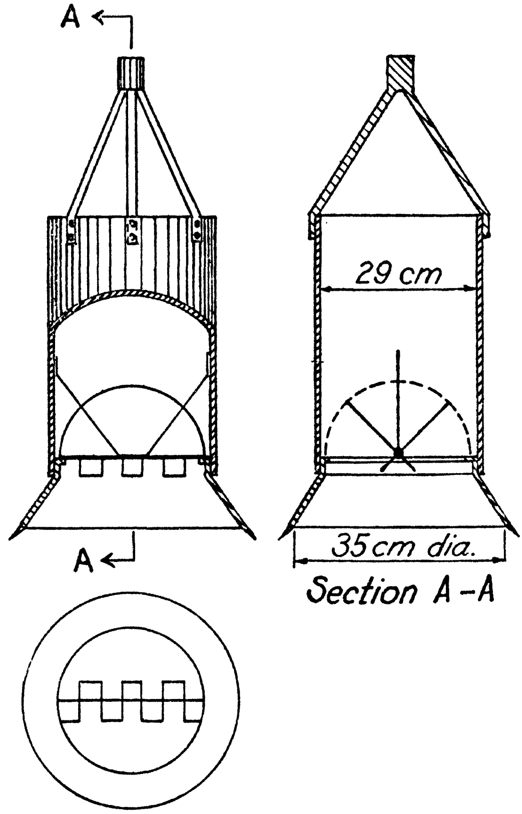

FIG. 26. A valve auger designed by Doctor Hamilton in Java.

opened quickly by hitting the catch, allowing the bottom with blades to swing on a hinge out of the way.

Doctor Hamilton designed the auger shown in fig. 26. We have not given this auger a trial and are not prepared to report upon its efficiency.

The engineers of the Sarawak Oil Fields designed the auger shown in fig. 27, but this auger costs 65 dollars to make locally without shaft or other accessories. It requires six men to handle it and no doubt is useful if properly handled.

OTHER CLAY AND SAND AUGERS

There are many kinds of these augers on the market. A style frequently used a number of years ago and still used in many places is the disc auger (fig. 28). We have tried a number of these augers but find them not as satisfactory as the other augers described.

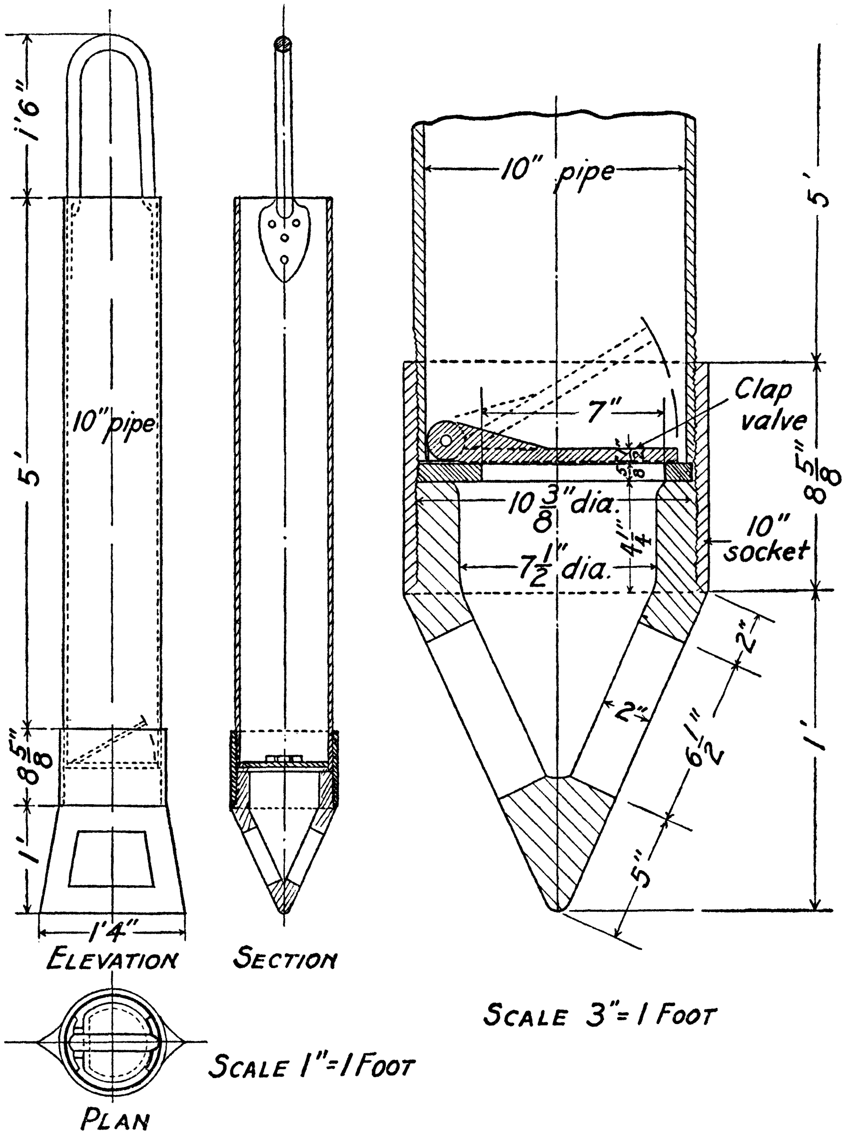

FIG. 27. A short chisel-bottom bailer designed by the engineering department, Sarawak Oil Field, Ltd., Miri, Sarawak. This drill should be a good one, but is expensive to make and requires six men to handle effectively.

The Standard earth auger (*fig. 29*).—In some places these augers, which are equipped with extension bits, have been used. They are fine augers for making holes of small diameter and have the advantage of being made so that the blades open to facili-

tate dumping. These augers give excellent service in certain kinds of work, but after a thorough trial in the Straits Settlements in making holes large enough for bored-hole latrines we decided in favor of other augers. The Iwan post-hole augers for instance cut 14- or 16-inch holes more rapidly in the variety of soils we encountered.

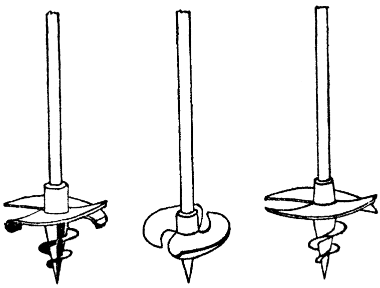

FIG. 28. Disc augers. These are probably the cheapest augers made, but are not as good as other augers mentioned.

The Lang borer (*fig. 30*).—This auger is used in a number of countries, but in early trials it did not meet with much success in the soil in the Straits Settlements. Holes were cut with the Iwan auger in one-third the time required in the same soil with the Lang borer. The handles and extension rods of the Lang borer are likely to bend, and there is a great waste of time using the coupled joints recommended by the manufacturer and in using the lifting bars sent with the auger. The suction created in some soils when lifting made this job difficult compared to other augers. An advantage of the Lang auger as equipped by the manufacturer is that it will work successfully in soft sand, and the Iwan post-hole auger will not work in very soft sand without modification. The Lang 14-inch auger with deep boring attachment costs 7 pounds 8 shil-

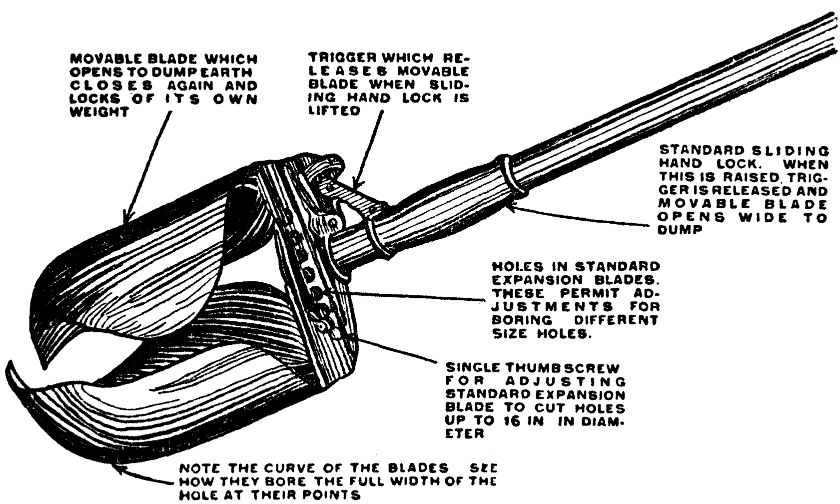

FIG. 29. The Standard auger, sold by the A. J. Alsdorf Corporation.

lings 9 pence, and with five extension rods, two levers, one spiral joint, and one steel chisel, costs 19 pounds 6 shillings 3 pence. A report recently received states that the Lang auger is now made with rods and handles heavy enough to stand the strain of deep latrine boring. If the manufacturer of this auger used a larger one-piece shaft and longer turning bands the cost could be reduced as well as the time required for boring. The coupled shaft is unnecessary for latrine boring in most places. The shaft as supplied can be taken apart for shipment, but this is not a great advantage, because an auger is usually used in one area for a long time and carried from house to house completely assembled.

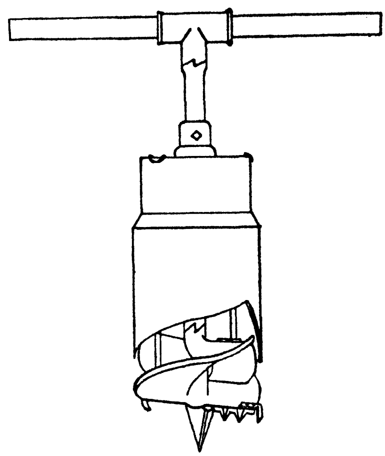

FIG. 30. The Lang-London, Ltd., auger. This auger is used in many places in clay and especially in soft sand. When used in sand a special screw, shown in fig. 18, *c*, is attached.

Howell's augers.—A variety of augers manufactured by R. R. Howell & Co., Minneapolis, Minnesota, and used by drive-well men are shown in fig. 31, *a* to *f*. These augers are too long and heavy for a squad of four men to handle. The spiral auger for loose sandy soil shown in the same illustration is carried in stock by the manufacturer in sizes up to 16 inches in diameter. The worm of this auger is 4 feet long. We have not tried this auger, but it would probably be more satisfactory for latrine work if made only half this length unless several men or a power-driven machine is used. The 12-, 14-, and 16-inch diameter augers cost 40, 45, and 50 dollars, respectively. These augers should be worked through a casing, if the sand does not pack tightly enough to keep it from running out.

The drop-bottom auger shown in fig. 31, *g*, has been used for years by well drillers. It is an excellent sand and clay auger but heavy, and the 16-inch size costs about 50 dollars.

The spudding jet auger shown in fig. 31, *h*, is for rock drilling but is slow and requires a heavy rig. It is used in well drilling but dynamite is faster and cheaper in latrine installation.

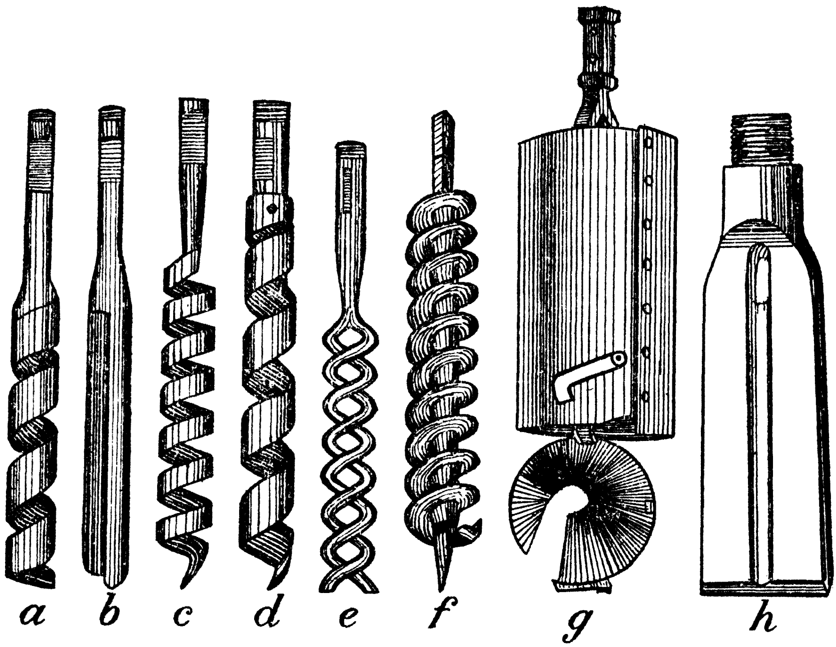

FIG. 31. Various earth augers manufactured by R. R. Howell & Co. *a*, For clay and hard pan; *b*, for boring and removing core; *c* and *d*, for general boring; *e*, for loosening and removing stones; *f*, for loose sand soil; *g*, a drop-bottom, fast-cutting auger especially useful with power-driven machines; *h*, a spudding, jetting drill used in rock drilling. Blasting is much more rapid for latrine installation in rock.

GEARED AUGERS FOR MAN POWER

Geared apparatus that can be turned by hand is made by a number of manufacturers, but the speed gained in drilling does not justify the expenditure for latrine boring and the apparatus is more difficult to transport and set up than the apparatus described in the first part of this article. The geared drills for making the 1-inch blast hole are worth the money. The geared hand augers made by Ingersoll-Rand for cutting 16-inch holes cost about 1,750 dollars United States currency.

ANIMAL-DRIVEN AUGERS

If horses, bulls, or other animals are available heavy rotary or studding drills can be used. These outfits are shown in fig. 32. In most villages where latrines are to be installed there is not enough working room to rig up apparatus of this kind, and by the time the outfit is set up a hole made by laborers would be well under way. Animal-driven boring apparatus is

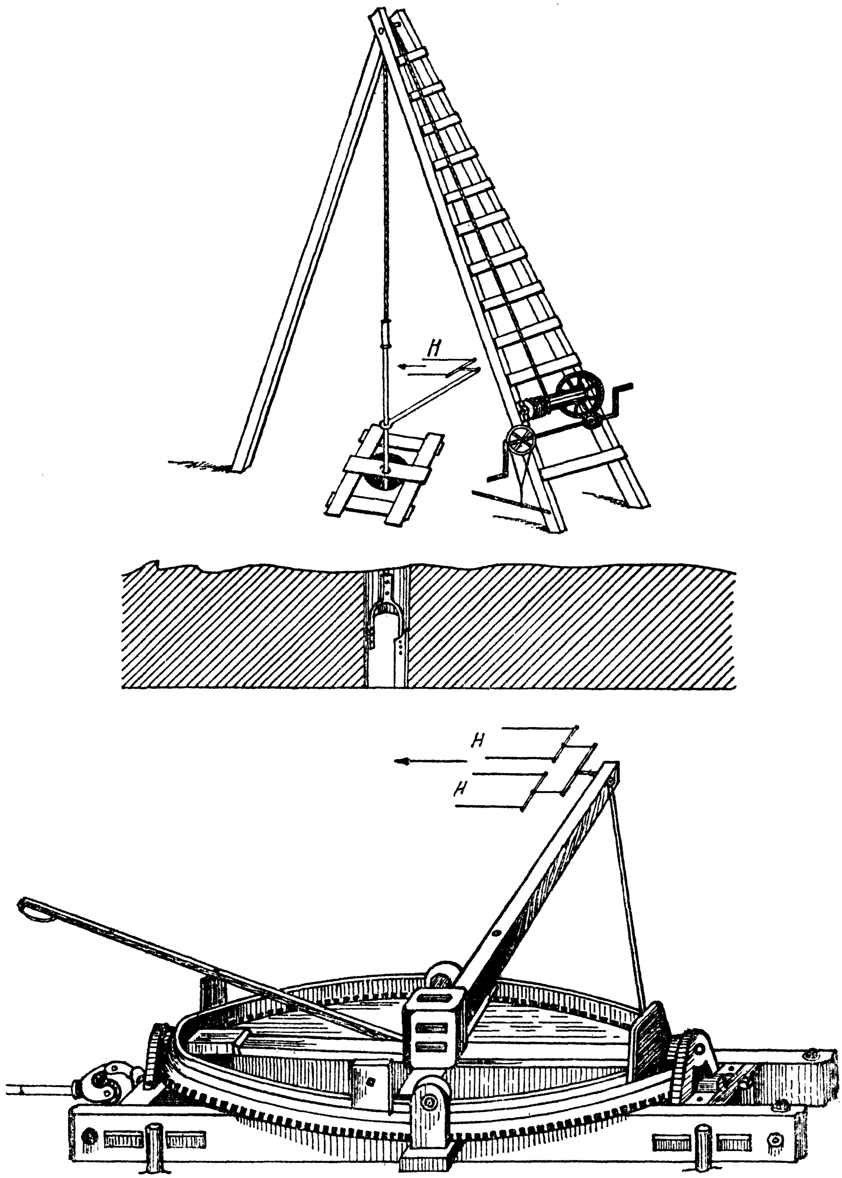

FIG. 32. Animal-driven boring apparatus. Used for many years in well drilling, but not suitable for rapid latrine boring.

valuable for deep-well drilling, but is not practical for 20-foot latrines; therefore, the heavy equipment used for this purpose will not be described in this article. Heavy augers, the bits of

which cost about 60 dollars each, have been designed for eight men or animals and do not speed up latrine boring enough to justify using them.

POWER-DRIVEN MACHINES

A power-driven auger to be of practical value must be small and easily transported. There is no doubt about the efficiency of these machines, and there are plenty of statistics to show that power-driven holes can be made for less money per hole than by man power in places where a large number of holes are to be bored.

BUDDA-HUBRON EARTH DRILL

One of the most compact, easily transported, rapid boring machines is the Budda-Hubron auger shown in fig. 33. For latrine boring this is the handiest and one of the most efficient machines on the market. It will bore in nearly all soil formations including shale, frozen ground, and hardpan. The apparatus usually sold for post holes bores to a depth of 10 feet.

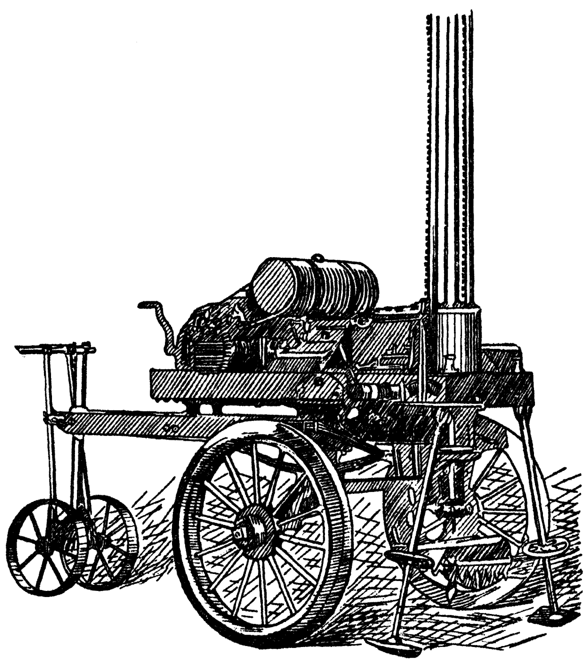

FIG. 33. The Budda Hubron machine drill. This is an efficient rotary drill, and takes less operating space than any machine we have heard of. It can be used for boring in clay, sand, hard pan, shale, and frozen ground. The stock machine bores holes 10 feet in depth, but the manufacturers will equip it for boring 20-foot holes. It costs about 2,400 dollars United States currency.

With special equipment this machine will bore a hole 20 feet deep. The machine can be equipped with small drills for making blast holes or holes up to a diameter of 24 inches. The manufacturer has certified records showing that this machine sunk fifty-four 7-foot by 22-inch holes in clay and gravel in nine hours at a cost of 0.454 dollar per hole. Hand methods cost 2.70 dollars per hole. Many other records are available.

THE GUS PECH MACHINE

The apparatus shown in fig. 34, manufactured by the Gus Pech Foundry and Manufacturing Company, requires an operation space of 10 by 16 feet, which rules it out for latrine installation in most places. The machine will bore from seventy to eighty post holes a day in some soils and will work in any kind of soil free from rocks. The machine is powerful enough to handle a 24-inch auger, and a reamer to cut 36-inch holes. There are some disadvantages in constructing these large diameter latrines, but if boring in an area where numerous large bowlders are encountered it is easier to remove these obstructions than to try to bore through them. A 16-inch drop bot-

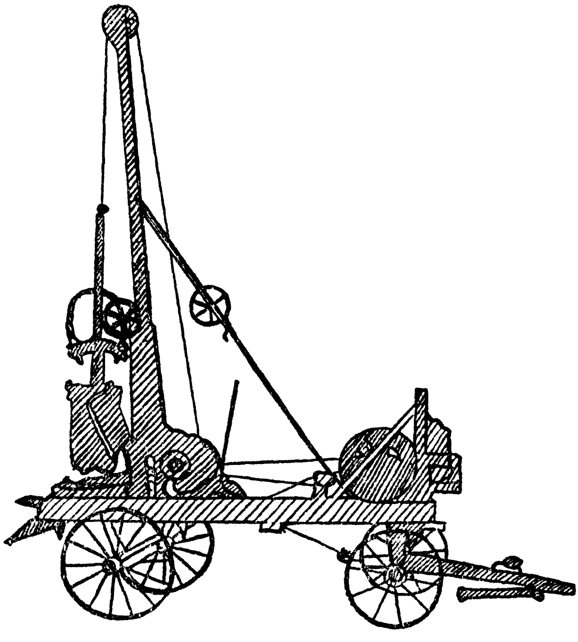

FIG. 34. The Gus Pech power-driven machine is a rapid borer, but requires a space 10 by 16 feet for efficient operation. It costs less than 1,000 dollars equipped for latrine boring.

tom, double-bit auger sells at 45 dollars. The 24-inch auger with reamer costs 60 dollars. Equipped to bore 16-inch holes 20 feet deep, a 6-horse-power gasoline engine, and a number of accessories, the machine sells for 842.50 dollars. There is an additional charge of 145 dollars for exportation boxing.

THE KEYSTONE, MONITOR, STAR, AND OTHER MACHINES

There are many machines, including those mentioned, on the market that I assume could be adapted to latrine boring, but I do not know of any better suited to the purpose than those described. All of the manufacturers making these machines deal in a large variety of augers and accessories. A disadvantage of all these machines is the large space required for operation. The Budda-Hubron requires less space than any power-driven machine that has come to my attention.

BORED-HOLE LATRINES IN ROCK

Expensive power equipment will cut through rock without difficulty, but to suit Philippine conditions it was necessary to develop an inexpensive method of latrine installation, because there are many towns near Manila and in other parts of the Islands built on strata of tuff. In an article submitted to the Rockefeller Foundation the formation, correctly named tuff, was referred to as adobe rock, as locally termed. Tuff in the Philippines is found in several degrees of hardness.

The softest tuff can be cut with a pick, but the hardest grades break into sharp-edged irregular pieces when blasted with dynamite, but is not as hard as granite or the solid rock formations met with in some places. The so-called adobe rock in the Philippines does not melt away in the rain as adobe does in many countries. This tuff stands weathering for centuries as seen in some of the old unprotected walls and churches. The harder formations of tuff offer more resistance to boring than the laterite frequently encountered in Malaya or the hardpan that is found in other countries. Tuff is a deposit of lava and volcanic ash that by pressure and other causes has hardened and forms extensive strata varying from a few inches to 30 feet or more in thickness.

Many towns are built on outcrops of this rock, where the pail system and other methods of disposal of dejecta were too expensive; therefore, such places had no latrines.

The problem of making holes economically in these areas seemed impracticable until the method of making tunnels for railways and water-ways led to the idea of making miniature tunnels vertically instead of horizontally. The method is the same in both instances. Dynamite does the work faster and cheaper than any auger made. In our first attempt we blew the surface of the earth to pieces several yards around the mouth of the hole, as shown in Plate 7, fig. 1, but with a little modification in the method, cylindrical holes with clean-cut mouths and straight sides can be made to any depth desired. We have installed hundreds of these latrines within a few feet of the houses. Some of these holes have been blasted within 2 feet of the walls of the houses and others have been put down under the floors. Any person who understands the use of dynamite can install these latrines in crowded communities without any danger to the inhabitants or houses.

The method of blasting varies according to the kind of rock encountered. Some of the tools employed are shown in fig. 35. Fig. 35, *a3* and *a4*, shows two views of a drill for making blast holes in hard rock. This drill is not needed in adobe formations.

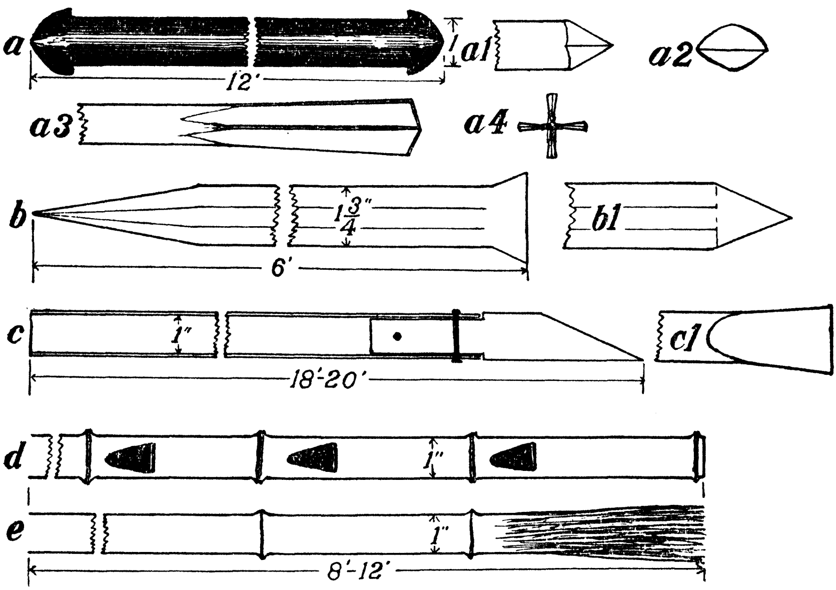

FIG. 35. Tools used for blasting latrines in rock. *a*, Bar used in drilling blast holes in tuff, adobe rock, and other hard formations; *a 3*, drill used with hammer for making blast holes in hard rock; *b*, crow bar used for starting latrine or straightening side; c, long bar used occasionally in deep latrines; *d*, bamboo bucket for removing water from blast holes; *e*, bamboo brush for cleaning mud out of blast holes.

Making holes in tuff.—If the stratum of the tuff lies 2 feet or more below the surface of the earth, the ordinary post-hole auger or shovels are used to cut the hole through the sandy clay earth down to the level of the hard layer. When this layer is reached, three to five small holes (fig. 36) about 1 inch in diameter and $2\frac{1}{2}$ feet deep are drilled with the steel bar shown in fig. 35, *a*. Each of these holes can be drilled in ten to fifteen minutes by using the bar with a ramming and twisting motion after pouring a little water into the hole. A hammer is not used except in very hard rock. The water and mud that accumulate in the holes are removed with the bamboo bucket shown in fig. 35, *d*, and the holes are cleaned out with the bamboo brush, *e*. The bucket, *d*, can easily be fashioned from bamboo with a pocket knife, and the brush is made by pounding the end of a bamboo pole. The position of the holes, the direction of drilling, and the charge of dynamite to be used in each, depend upon the work to be done. One blast hole in the center of a large 16-inch hole with a large charge of dynamite is not satisfactory if the large hole is shallow, because the blast will destroy the surface. Better results are obtained in making 16-inch cylindrical holes if three to five small holes are drilled in the position indicated in fig. 36, *a*. A charge of one stick of $\frac{3}{4}$-inch 40 per cent dynamite in each small hole is sufficient. The fuses are all ignited as rapidly as possible. The explosions follow each other in rapid succession.

When the latrine is 4 to 6 feet deep, the dynamite will break up the adobe or pulverize it to an additional depth of 3 to 5 feet below the bottom of the blast holes. If the adobe pulverizes an auger is used to remove it, but if it breaks into pieces a bucket and rope is used. A man can be let down into the hole to gather up the larger pieces of rock. We make latrines at least 16 inches in diameter if men must go down. At this stage after the adobe is removed it will be found that the latrine is from 9 to 11 feet deep. Another series of small holes (fig. 36, *c*,) with another charge will be enough to make a latrine pit about 18 feet deep. We frequently drill three or four blast holes at the first level, four at the second level *b*, and five for the last detonation at level *c*, placing one or two sticks of dynamite in each hole.

If the adobe is an outcrop and not covered with soft earth, a hole about 16 inches in diameter and 18 to 24 inches deep should be cut into it with a chisel-shaped bar (fig. 35, *b*). If the rock is very hard the work may be expedited by a few light charges

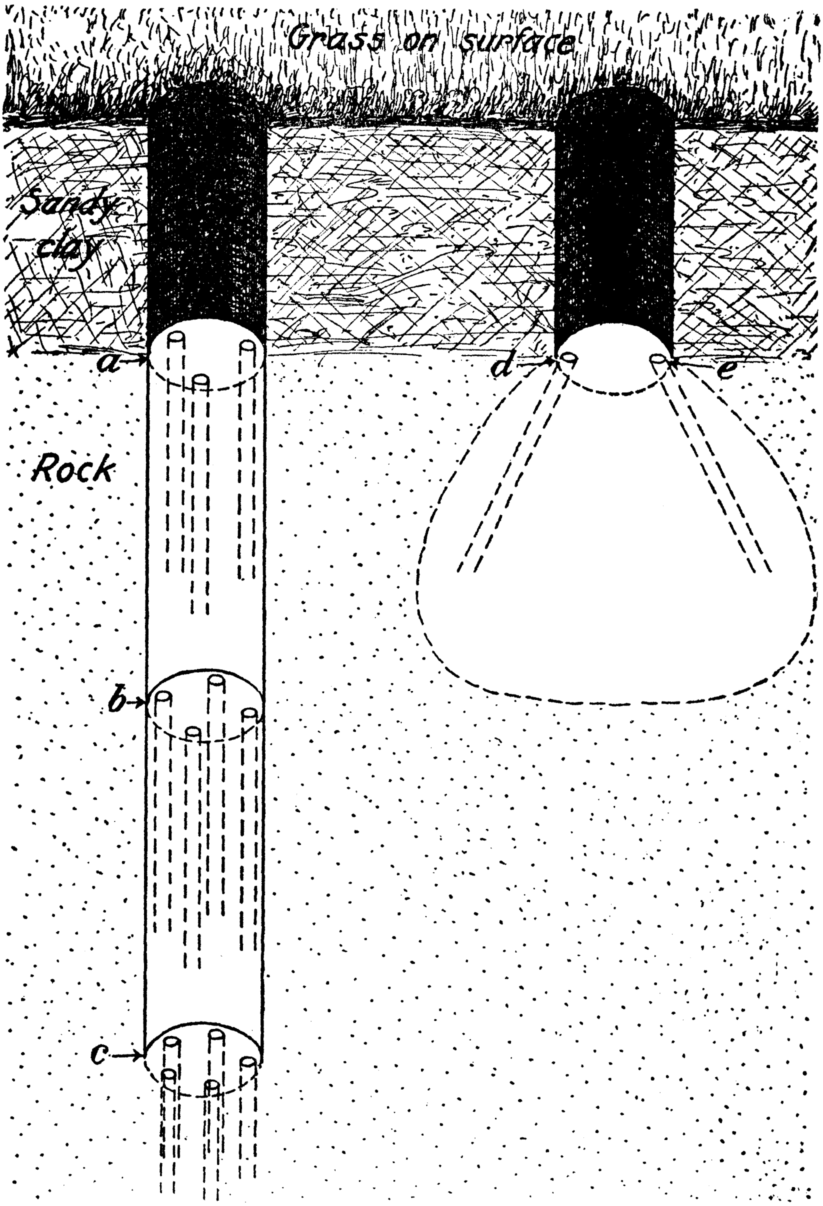

FIG. 36. Blasting in rock. *a* to *e*, Positions of blast holes. In hard rock five blast holes are drilled at *a* and *b*.

of dynamite; but this is not often necessary even in the hardest tuff. When the large hole is 1½ to 2 feet deep, the work of charging the small holes with one stick of dynamite each can proceed without damage to the surface. Sometimes the dyna-

mite will blast out a wide hole beneath the mouth of the small hole, and leave a shelf in the latrine. This shelf can usually be broken through with the long chisel (fig. 35, *c*) or, if necessary, a small charge of dynamite may be used.

Dynamite does not blow long fissures in comparatively soft tuff, but usually pulverizes it so that it can easily be removed with an auger. Occasionally, broken pieces several inches long and of irregular shape are blasted loose. The dynamite can be set off with the usual fuse and cap, but if much work is to be done it would probably be better, in the long run, to use an electric machine for this purpose.

In most places we have made straight cylindrical holes 18 to 20 feet deep. In other places we have first made holes 15 inches in diameter and 6 or 8 feet deep, and then, by drilling two small holes at an angle (fig. 36, *d* and *e*), have made the large hole 3 or 4 feet in diameter down to a depth of about 10 feet. At one school we constructed a series of five holes 3 feet from center to center, and then blew out the partitions at the bottom, thus connecting the holes by an opening large enough to permit a man to walk from one hole to the other. In other places we have connected and installed pipes in the partitions so that the holes acted as a septic tank. There was sufficient absorption in the holes in soft adobe that a pipe to carry off effluent was not needed.

Holes in the hardest tuff will give better service if the area around the bottom is split into fissures to allow greater absorption. This is done by drilling one blast hole in the center at the bottom of the latrine and setting off a charge of several sticks of dynamite. This will blast numerous fissures several feet long in all directions. If the rock is not then sufficiently absorbent, two latrines should be made so that the dejecta can be allowed to age in one hole while the other latrine is being used. It is easier to pump out a full latrine than to bore a new one in rock. A machine and hand-driven pump are used in the Philippines for pumping out latrines.

We have used from two to twelve sticks of dynamite in making holes in various kinds of tuff. In a large school latrine an average of seven sticks per hole was used. With the tools mentioned, two men can install a latrine in tuff in a day or less. Dynamite costs 24 pesos, or 12 dollars United States currency, for a case of two hundred sticks, delivered in Manila. In hard tuff the dynamite for one latrine costs from 42 to 72 cents. The

cost of installation, while higher than boring in soft earth, is cheaper in most places than any other method of latrine construction in hard formations. Dynamite and labor cost about 4.50 pesos per hole if only twelve men are hired to lower the overhead cost per hole. The foreman's wages of 3 pesos per day are included in the cost.

The cost can be considerably lowered by spending a little more money for tools. We had a special blast-hole drill made by the Howells Mining Drill Company that speeds up the work. It not only bores the blast hole but automatically cleans the hole while boring. This auger, shown in fig. 37, costs 18 dollars delivered, including an extra twist drill. The drill will cut adobe rock, shale, laterite, hardpan, and other hard formations. It will not cut the hardest grades of tuff. A more-rapid automatic feed, geared drill that costs 140 dollars is shown in fig. 38. Air and electric drills are much faster and will cut hard rock but are expensive unless there is a great deal of work to be done.

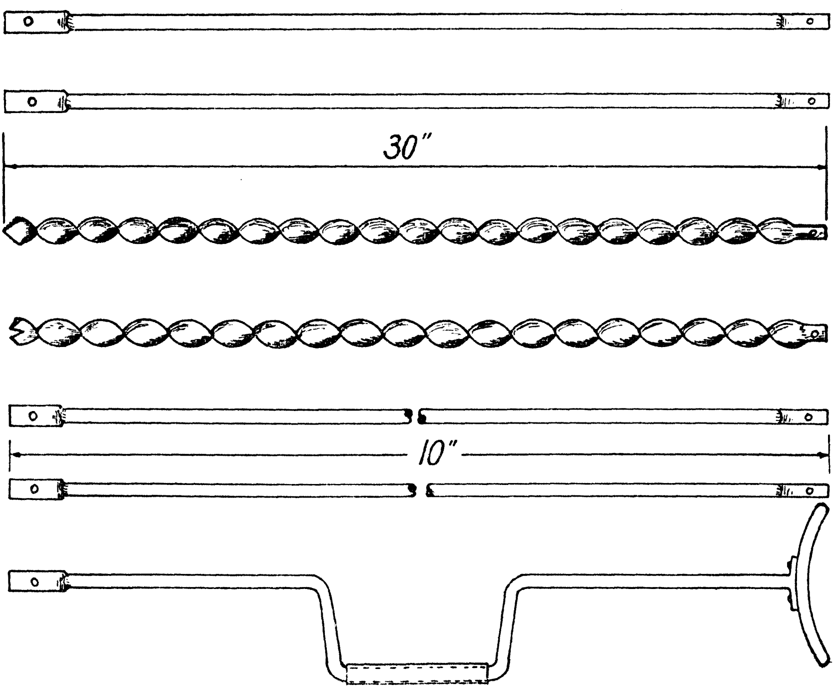

FIG. 37. A hand drill especially designed for making blast holes in tuff, adobe rock, shale, or other hard formations. It will not cut hard rock. This drill cuts the holes rapidly and cleans them out at the same time; it is constantly used now in place of the bar *a*, fig. 35 except in the hardest rock where the drill *a*3 is used. Manufactured by the Howells Mining Drill Co., Plymouth, Pa. Cost about 18 dollars.

Dynamite exerts a more powerful explosive force in hard formations than in soft material, and the hardest rock cannot resist a charge of dynamite. While this method has not been used for our latrine installation in the hardest kinds of rock, it is believed that the method will work in any rock formation, and in any formation is much more rapid than the spudding rock drill shown in fig. 31, *h*, or any other drill designed for hard formations.

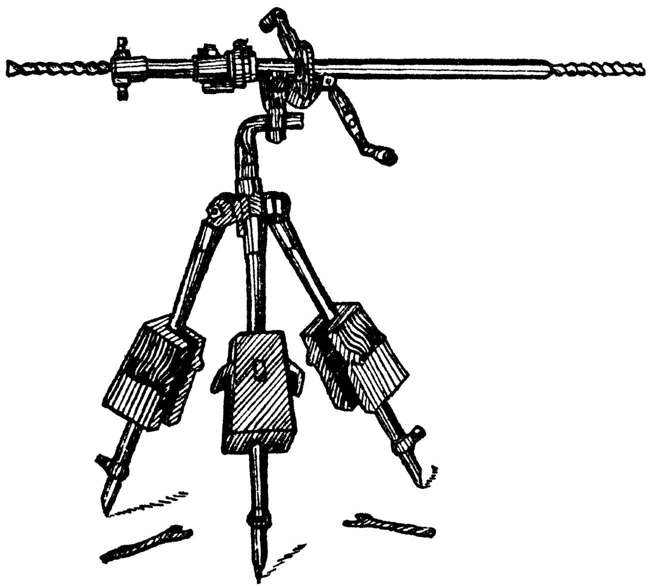

FIG. 38. A geared drill for boring blast holes rapidly in very hard formation except hard rock. Manufactured by Howells Mining Drill Co., Plymouth, Pa. Cost, 140 dollars.

LATRINE CONSTRUCTION

The method used in making holes in rock might have been included in section under Construction but a description of the tools used should be included under equipment, so the method of using the tools was included with the description of the tools in order to describe completely the method of latrine installation in rock without referring to other parts of the article.

Boring latrines in ordinary soils.—The method of using the hand auger needs no detailed description. The auger is turned until full and then pulled up and emptied. After a few trials the number of turns necessary to fill the auger can be determined. The number of turns varies in different soils. The Iwan post-hole auger takes about 6 inches of soil every time it

is filled. This observation is useful when boring under water where the auger cannot be seen. A mark on the shaft can be noted and when it reaches a level of 6 inches below the starting position it indicates that the auger is full and ready to be hoisted and emptied. Soft soil can at times be kept from falling

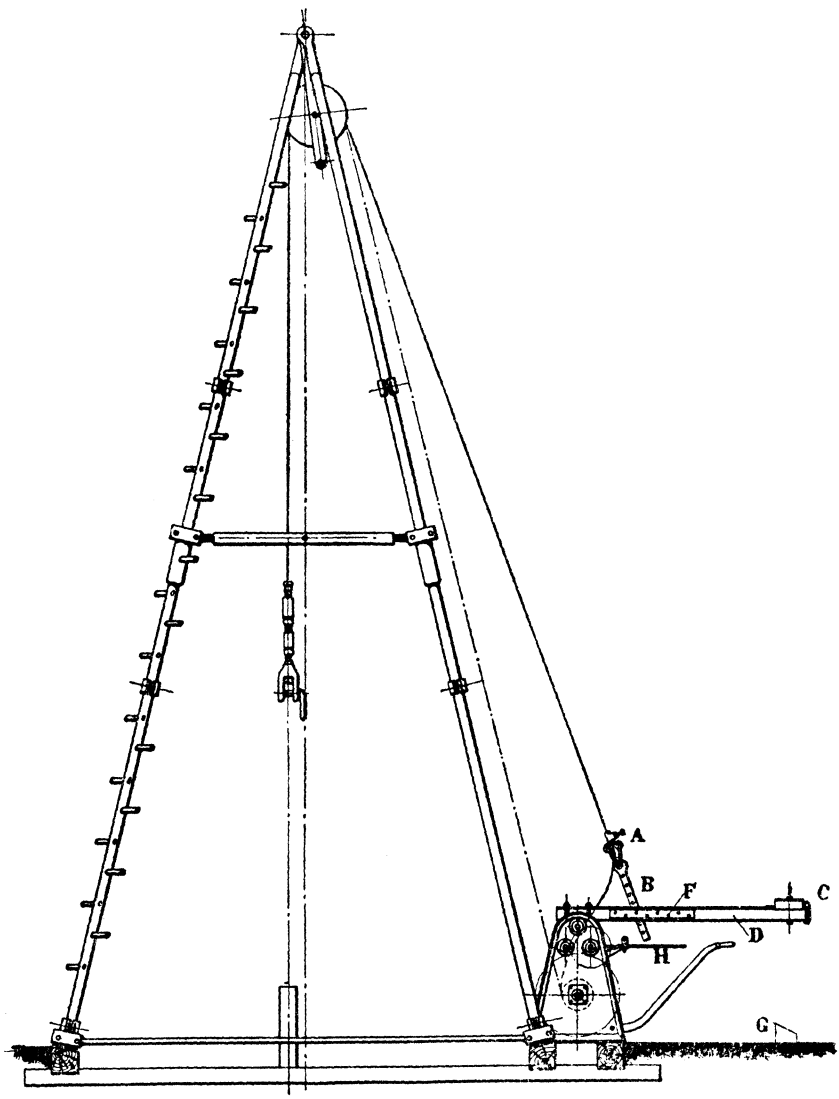

FIG. 39. Derrick manufactured by Werf Conrad, Haarlem, Holland. For rotary, percussion, or free-ball system of boring. This apparatus will handle heavy drills. It is too heavy for general bored-latrine work.

out of the auger by a smooth steady pull instead of a jerky motion when lifting. Some soils will not fall out of the auger until after it is pulled out of the water. At times it is best to continue a steady pull all the way up, and in other instances it is advisable to stop lifting as soon as the auger is pulled above the surface of the water to let the excess water drain out about a half minute, allowing the soil to pack itself and then continue hoisting.

Soils of average consistency pack so tightly in the auger that they must be removed with a small scoop or sharpened paddle made of metal or wood. Boring is easier in very dry soils if water is poured into the hole.

Bored latrines can be installed in places where water is not encountered, but the disintegration of the dejecta appears to be not as rapid or complete as in latrines with a meter or two of water in them. The dry latrines evidently do not last as long as those containing water, but with proper use a latrine not containing water should not be filled by an average family in less than four years. We had a complaint in which two latrines were reported filled within seven months, but investigation showed that nearly one hundred persons were using these two latrines. Ample provision should always be made to install a reasonable number of latrines for the convenience of the persons who will use them. There are records of other latrines lasting three years and not yet half full. In these instances from eight to twenty persons used the latrines daily.

A squad of four men can easily bore an average of three latrines a day in sandy clay. This includes setting up the apparatus and time lost in transportation, and covers work by the month, and not a spurt of energy for only a few days.

Caving soil.—Lining or reënforcement to prevent caving are important features of construction. There is one area in the Philippine Islands where the people went ahead with bored-hole latrine installation without preliminary consideration of the soil encountered, and no trial latrines were bored before general installation started. Evidently in this area the soil was of a consistency that the walls of the latrines did not cave in when bored, but when the heavy rains came most of the latrines filled up with caved-in soil. This was damaging to our propaganda because a number of persons were convinced that bored-hole latrines are not suitable for the Philippine Islands.

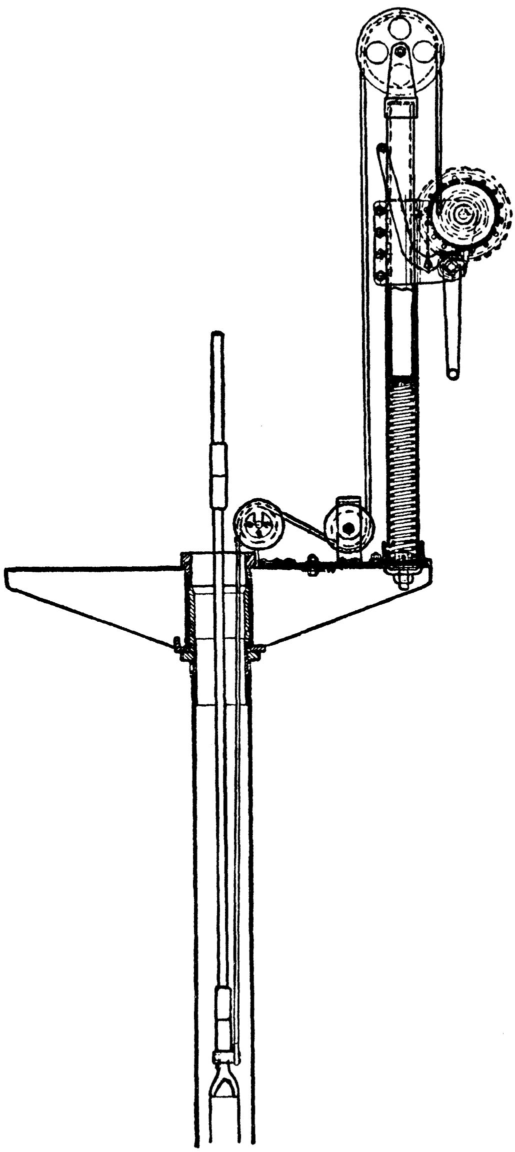

FIG. 40. Hand-power spudding and hoisting windlass manufactured by Werf Conrad, Haarlem, Holland. Believed to be too expensive (about 200 dollars) and too bulky for general distribution for latrine boring.

In many places the earth caves in only at the mouth of the latrine. In these areas wooden cement kegs which can usually be obtained at no expense are used. One cement keg pushed into

the mouth of the latrine and allowed to extend about 6 inches above the mouth is a commonly used method. Clay is packed around the protruding keg, the slab is placed on top, and then the superstructure is built.

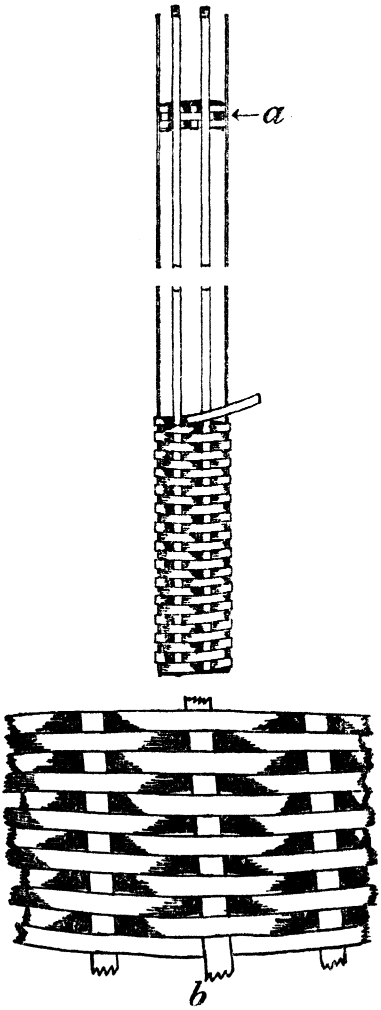

FIG. 41. Woven-bamboo cylinder partly made. This makes a very satisfactory latrine lining in most places. The section *a* is a temporary support to keep the ribs straight while weaving; *b* is an enlarged section of the woven-bamboo latrine lining.

To prevent caving in areas where the walls are likely to cave in the entire depth of the latrine, plaited bamboo or wickerwork linings, or cylinders made of cement, clay, wire, wood, or sheet metal are used. Drums or kegs placed end on end have been frequently used in the Philippines. The bamboo linings are very satisfactory especially if coated with coal tar or some other wood preservative. In some places the latrines are bored to a depth of 12 or 14 feet below the water level. Bamboo under water lasts years without a preservative; therefore, in these areas it is not necessary to use a preservative on the portion of the lining that will remain under water. The wood extending above the water level is more likely to rot or be eaten by insects. In many tropical countries the bamboo will last as long as the latrine and is cheaper to replace if necessary than to use preservatives. A woven bamboo lining is shown in fig. 41, *a*, and an enlarged sketch showing the weaving is shown in fig. 41, *b*. These woven linings were first used in Java and have been used satisfactorily in the Straits Settlements, and are extensively used in the Philippine Islands and other countries. The bamboo cylinder can also be made by tying long

bamboo strips to hoops. In some places where they do not have bamboo they fasten strips of another kind of wood to metal or wooden hoops.

Dr. Victor G. Heiser suggested the use of an open mesh galvanized wire screen as this would allow the bacteria naturally in the soil to act on the dejecta and also allow permeation of the latrine contents into the soil. We have recently tried wire screen made into cylinders as shown in fig. 42, *a*. The only disadvantage is that chemical action might cause rapid disintegration of the metal. In some places the bamboo cylinders would probably last longer, but wire can be obtained in places where there is no bamboo. A thin wire netting ordinarily called chicken wire net can be reënforced with wood or iron hoops, but is too flimsy for practical use. A mesh of $\frac{1}{4}$-, $\frac{1}{2}$- or 1-inch heavy wire does not require the hoops and withstands corrosion longer. These cylinders cost about 3 pesos for each section 3 feet long. Sheet-metal cylinders can be made as described in the next paragraph, but numerous holes should be chopped into the metal to allow better action on the dejecta.

Silting-earth reënforcement.—In order to prevent caving in silting earth a solid lining is required. Bamboo cylinders are very satisfactory in some places, but we have frequently found

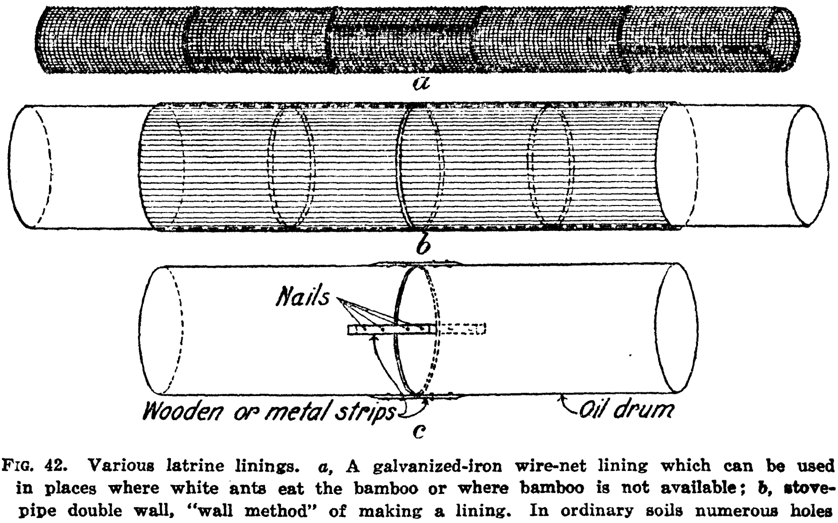

FIG. 42. Various latrine linings. *a*, A galvanized-iron wire-net lining which can be used in places where white ants eat the bamboo or where bamboo is not available; *b*, stovepipe double wall, "wall method" of making a lining. In ordinary soils numerous holes can be cut into the metal to allow better action. In silting soils the sections are added one at a time as boring proceeds. A few dents hold the cylinders together; *c*, four to six empty metal oil or tar drums placed end on end are frequently used as linings for latrines. The heads of the drums are cut out with a chisel. Wooden or metal strips are nailed to the drums to make strong joints. These are often used in silting sand.

it necessary to cover the cylinder with a thin coat of clay or weak mixture of cement in order to prevent very soft sand from silting through the small openings in the cylinders.

In most places in the Philippines we use cylinders that we can get for little or nothing. Heavy sheet-iron oil drums with the ends cut out and tar and cement drums have been very satisfactory. We frequently use wooden cement kegs placed end on end.

When using sheet-metal linings in soft sand we rivet the cylinders with five or six small rivets. We make the cylinders 3 feet long for convenience in handling. A few slits can be chopped into the lower cylinders to allow a rise and fall of water if necessary. Each cylinder is slit in four places at one end to allow it to be inserted an inch into the next cylinder.

Stove-pipe method of lining.—When only very thin sheet metal is available we use the stove-pipe-well method. A number of cylinders are made in two diameters each 3 feet long so that the smaller cylinders can be telescoped or slid into the larger cylinders. These make an excellent reënforcement and are convenient for boring in very soft sand. The joints overlap in the center and a few dents with a hammer prevent slipping. Fig. 42, *b,* shows the position of the joints.

If the soil is stiff enough to hold its shape long enough to bore to the required depth, the lining is put down in one or two long pieces. If the soil constantly caves in from the sides while boring, the cylinders, which are a couple of inches larger in diameter than the auger, are put down the latrine one section at a time, and the sand is pulled up through the cylinder by the auger. The cylinders are pushed down every few minutes in order to block off the silting soil as rapidly as the auger cuts. If thin metal cylinders are used, a hoop of iron should be fastened around the bottom cylinder to maintain a circular opening. If this is not done the sides will be compressed by the mud or sand and the auger will not turn or will hook under the edge of the cylinder.

Iron oil drums with the ends cut out and placed end on end are used in the same way as the sheet-metal cylinders, and have been very useful in reducing the cost of latrines in soft silting sand and mud near Manila. A satisfactory way to joint the cylinders together is shown in fig. 42, *c.* Three or four strips of wood hold the joint solidly. Nails are driven through the wooden strips and drum and clinched on the inside. Nails are

difficult to drive into heavy oil drums unless holes are previously punched through.

Slabs or floors.—Under exceptional circumstances we have allowed the use of wooden slabs or floors in latrines but for obvious reasons usually insist upon the use of cement slabs. A variety of slabs have been designed in many countries with as many different sizes and shapes of holes. In some places plain reënforced concrete slabs are made with rectangular holes in the center. In other places they use elevated treads or so-called foot plates for the feet to prevent fouling. A slab that has been used successfully in Java is shown in Plate 7, fig. 2. Plate 1 is one of the types recommended by the Government of Madras, India. They also use a circular slab. The Java slab costs less and is the smallest slab we have heard of. In other places they use slabs over 4 feet long. In the Philippines we most frequently use the reënforced slab shown in Plate 2. This slab is 30 inches wide and 36 inches long. It is 2½ inches thick at the outside with a sloping surface for drainage reducing the thickness to 2 inches at the edges of the holes. The edges of the holes are cut back to prevent fouling. Knowing of two instances in which children fell through holes 8 by 18 inches in one country, the rectangular hole in the slab used in the Philippines is made only 5¾ inches wide and 13 inches long. In casting the slabs a notch 3 inches on each side is made at each corner for the posts of the superstructure. This allows the walls to be built close up to the edge of the slab.

Another kind of slab is also used in the Philippines; it is of the same general dimensions but with the hole narrowed at the front and with two elevated treads or foot plates for the feet. This slab costs a little more to make than the plain slab, which costs from 1.85 to 2.45 pesos including ¼-inch twisted wire reenforcement, a 1, 2, 3 mixture of concrete, and the labor. The plain slabs are more easily handled in shipping than those with treads, and up to the present time have not been found fouled any more frequently than the slabs with foot plates.

Dr. W. P. Jacocks designed an excellent latrine floor or "squatting plate" for Ceylon. This plate is made of 18-gauge pressed steel and can be purchased for 4 rupees or less from Messrs. Walker, Sons & Co., Ltd., Colombo (fig. 43).

The floors of latrines should always be at least 18 inches above the highest water level. If the water level is several feet below the surface of the earth and the rainy or flood season does not

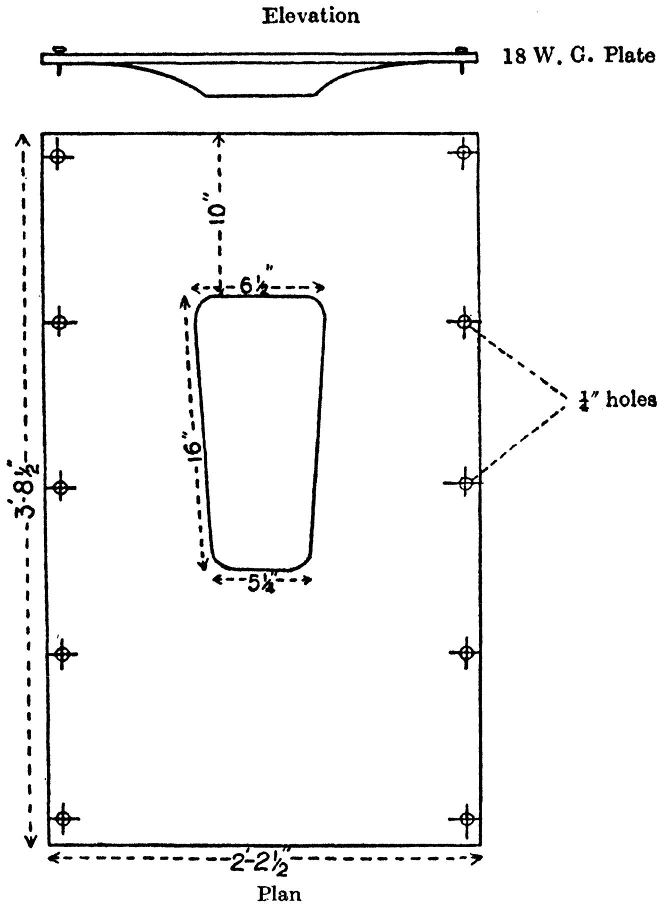

FIG. 43. A steel latrine floor, or squatting plate, designed by Dr. W. P. Jacocks for use in Ceylon. The cost is about 4 rupees, about 2.60 pesos.

raise the water to the surface the slab can be placed directly over the hole on a level with the surrounding soil.

In places where the water floods over the area the floor and the superstructure can be built upon mounds of clay. In these places the lining can be allowed to extend above the surface of the earth to the required level and clay, bricks, stones, cement, or other material can be placed around the protruding lining to support the slab. We sometimes use blocks of tuff or adobe cemented with clay or lime, but in most instances on account of the possibility of spreading infection from the latrine we use cement to make the structure solid and without crevices.

At times we run the cement a foot or more below the surface down around the lining or dig a small trench about a foot away

from the bored hole and fill this with cement. While there is probably no seepage under a heavy slab with its support, the above precaution tends more completely to block any exit of infection. In places where the people do not have enough money to build a solid structure, we frequently use discarded oil drums with the ends cut out for the support of the slab. The drum extends about a foot into the mouth of the latrine and 2 feet above the surface where the water floods the area to about a foot in depth.

The water trap.—There are many houses equipped with flush water closets emptying into bored latrines. In some of these two or three bored holes are connected together with pipes and are better than many septic tanks. Where they do not have piped-in water but have the money to purchase a porcelain water closet, the bowl is placed on the slab directly over the bored hole and after using is flushed with a bucket of water.

One of the advantages of the bored-hole latrine installed in suitable places where the subsoil water is encountered at a depth of about 16 feet, is that mosquitoes, flies, and other objectionable insects do not breed in the latrines and no bad odors are emitted. One objection to the bored latrine in places where the ground water lies within a few feet of the surface of the earth is that it furnishes a breeding place for flies and mosquitoes and is offensive unless properly constructed. The ordinary slab is not satisfactory in these places and the cost of vitreous china bowls is too great for a large proportion of the rural inhabitants. To meet the demand reënforced concrete water traps have been made. The design first used was copied from a porcelain water closet. A small bucket of water is sufficient to flush the bowl completely. One feature of the trap is a clean-out hole, which facilitates cleaning when necessary. These traps have been greatly improved by making them longer and putting foot treads on them. We have now two types of traps so designed that the dejecta must fall where supposed to at the back of the water closet. It is impossible to squat on these water closets backwards because the treads slope to the front and throw a person off balance when he tries to squat on the trap the wrong way.

One of these water closets is designed to be placed on top of a concrete slab, and the other is designed so that it fits flush with the slab, except the treads, so that the floor drains into the trap. The traps are made of cement and cost about 4 pesos each for

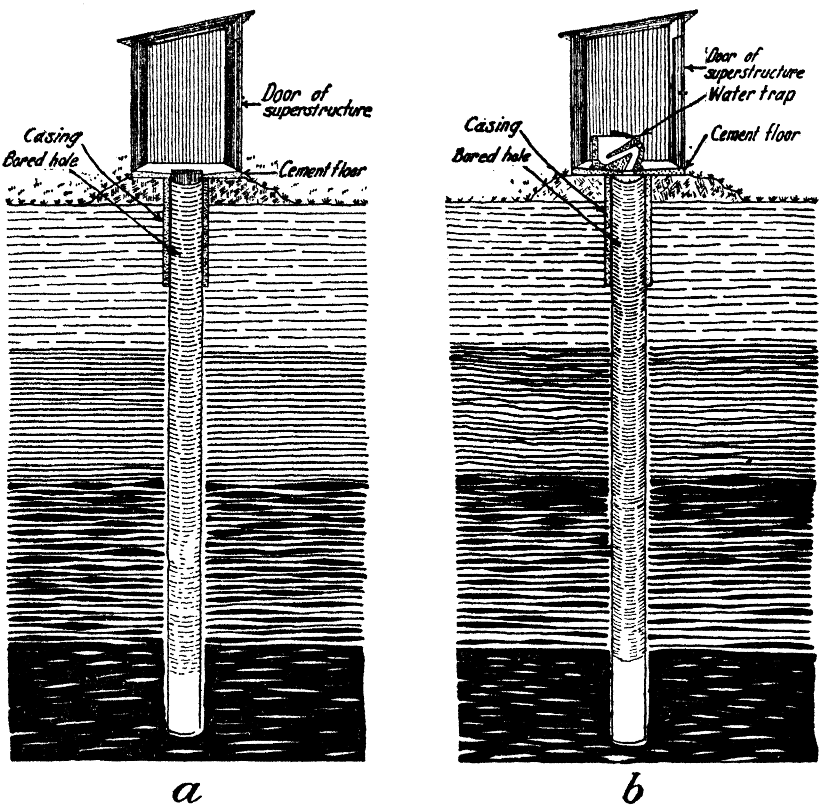

FIG. 44. Latrine and water closet. *a*, The bored-hole latrine complete with superstructure. The lining and cement casing are not used in soil that does not cave into the latrine. Metal drums are usually used instead of cement casings where the water rises to the surface; *b*, a cement water closet that can be flushed with a bucket of water. About two hundred of these water traps are giving excellent service in the Philippines. The sloping foot rests make the user sit on the water closet correctly. The rests throw one off balance if he attempts to squat backwards. These traps cost about 4 pesos each. They absolutely eliminate fly and mosquito breeding and foul odors.

material and labor. A few baked-clay traps have been made, but these are not as satisfactory as the cement water closets (Plate 4 and figs. 44 to 46).

We recommend these flush water closets for private families only and not for use in public latrines, because careless people block them with rubbish. Nearly two hundred water traps have been in use over a year and are a very satisfactory improvement to latrines where the water level is high.

These traps have been placed over latrines that were covered with swarming maggots and emitted very objectionable odors.

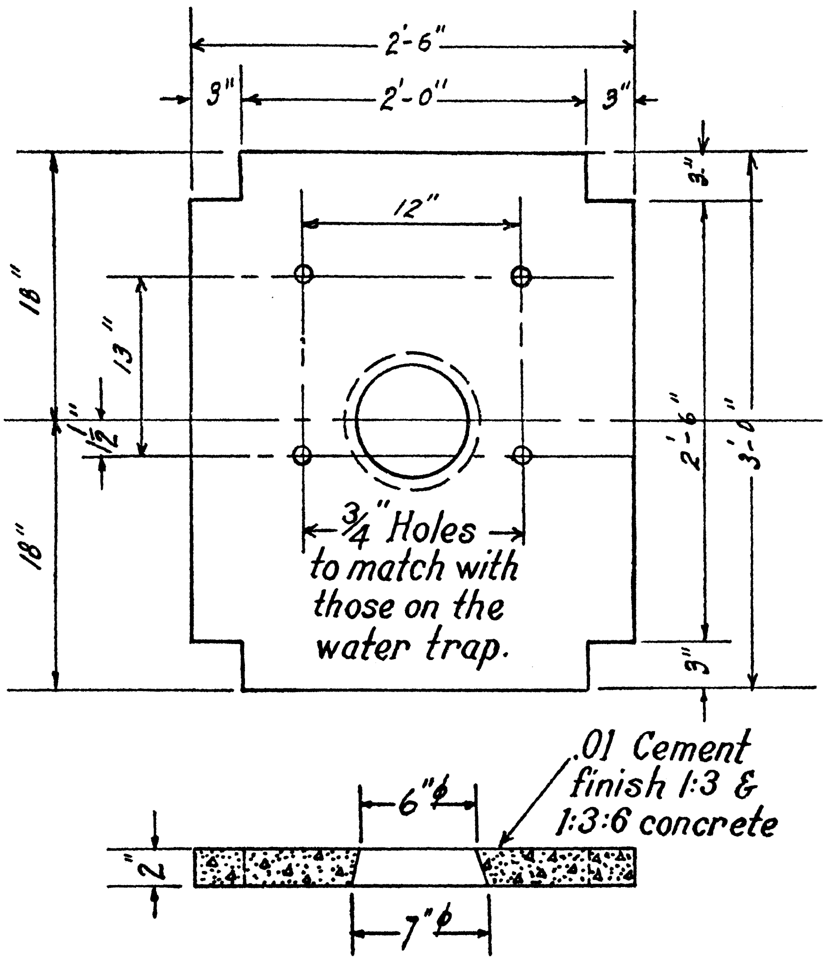

FIG. 45. Reënforced concrete slab for use with water trap. Elevated type.

After installation of the traps and cleaning the latrines there was no longer any fly or mosquito breeding and the odor disappeared immediately. Another advantage of the trap is that the people learn almost immediately to use water or paper instead of sticks and other articles, and the latrines will serve a greater length of time.

Superstructures.—In this section on latrine construction there is no attempt to discuss the building of superstructures. There are so many kinds of superstructures that are satisfactory and the details are of such little importance, as far as the prevention of disease is concerned, except in one point, that it is unneces-

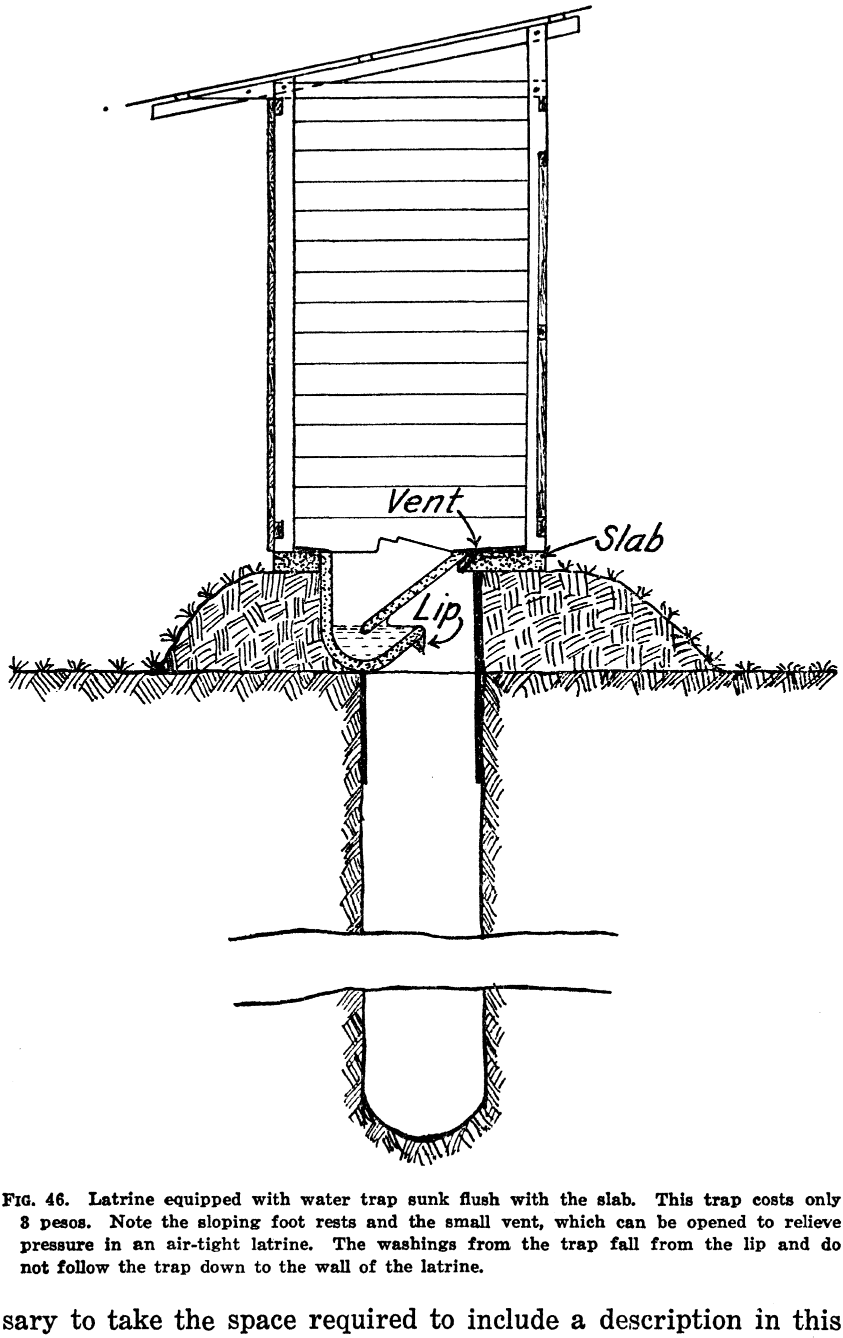

FIG. 46. Latrine equipped with water trap sunk flush with the slab. This trap costs only 8 pesos. Note the sloping foot rests and the small vent, which can be opened to relieve pressure in an air-tight latrine. The washings from the trap fall from the lip and do not follow the trap down to the wall of the latrine.

sary to take the space required to include a description in this article. Sometimes the latrines are bored so that the seat or slab can be placed in the house or in a position easily accessible

by an elevated board walk leading from the house to the latrine. There are many places in our rural areas where they do not build a complete superstructure, but only palm leave partitions on three sides of the latrine with a screen of palm leaves erected a couple of feet in front of the entrance for privacy. There is only one detail in the building of superstructures in which we are particular and in which the builders of the superstructures are more or less careless. In some places they build the superstructure so large that a space of a foot or more of earth is left uncovered by flooring between the slab and the walls of the superstructure. In these instances there is danger of soil pollution around the sides of the slab where the earth is shady and moist and this furnishes an excellent culture medium for parasitic larvæ and other disease organisms. We insist upon the walls of the building being placed against the slab so that the floor of the latrine is all concrete.

A complete bored latrine of the usual type is shown in fig. 44, *a.* The bamboo lining and a cement or iron casing shown in this picture are not needed in solid ground which does not cave in.

The laborers' privy as built with a seat by the United Fruit Company is shown in Plate 5. This sketch also shows their method of lining latrines.

Dr. Louis Schapiro forwarded a pamphlet to us from Siam showing an ingenuous latrine that is fool proof as far as keeping the hole in the floor covered. In order to use this latrine the lid must be pushed back. When the lid is in the open position the door cannot be opened because it strikes a handle on the lid. Therefore, in order to leave the latrine the lid must be closed so that the door can be opened (Plate 6).

BACTERIAL MIGRATION

Regardless of the results of the experimental work attempting to determine the limits of bacterial migration, it is advisable to frequently examine well water for pollution in every community. Some of the work done in the past throws some light on the possibilities of pollution. There is considerable evidence showing that bacteria do not travel more than a few feet in dry soil and in some instances not even one foot from the latrine, but more information is needed to show the distance bacteria will travel in ground water. Bacteria have been carried several thousand feet in ground water flowing through fissures in lime stone and other formations.

W. A. Hardenbergh discusses the results of a considerable amount of work on pollution in his book on home sewage disposal. The United States Public Health Service, through an experimental board directed by Dr. Charles Wardell Stiles, reports bacterial migration 200 or 300 feet, and states that possibly greater distances are covered under most favorable conditions.

Stiles, in "The principles underlying the movement of Bacillus coli in ground water, with resulting pollution of wells," states that *B. coli* were found in ground water 65 feet from a polluted trench. These bacteria evidently traveled through a fine sand with an effective size of 0.13 millimeter. It took 187 days for *B. coli* to travel this distance, and the migration was only in the direction of the flow of the ground water. In another article, "Experimental distribution of Bacillus coli in the soil under and near pits," by C. W. Stiles and C. L. Pfau, it is stated that *B. coli* were carried in ground water up to at least 232 feet.

Space cannot be given in this article to discuss the viability of organisms, but the resistance of the pathogenic bacteria which are likely to infect man through drinking water is not great. Most of these bacteria die within a few days. Typhoid bacilli might live months in polluted soil on the surface, but the bactericidal action at ground-water levels is greater. Kligler states, typhoid and dysentery bacilli may be recovered up to seventy days in moist natural soil. The rapidity of time in transmission is an important factor in well pollution.

Although Stiles found no convincing evidence of the travel of *B. coli* against the flow of the ground water, there is no reason why these bacteria and other organisms could not migrate against the flow in some places. In areas where the water does not flow constantly in one direction or at times is almost at a standstill, the motility of the organisms as well as migration by growth would be factors in the spread. Cholera and choleralike vibrios can actually travel against the flow of a current. Schöbl has demonstrated this point many times. Hardenbergh states that "pollution appears to travel against the flow of ground water as well as with it." Other workers have made similar observations. However, the migration of bacteria against the flow is relatively unimportant.

A factor in migration that is sometimes not considered is the kind of soil in which small channels form. In some soils there is practically an even filtration. In other soils of the same effective size of sand there is a cohesive quality which affects filtration. An even filtration might be expected, but examination reveals

that the water is flowing into the well in small rapid-flowing streams through a few long channels some of which are branched. In these places the bacteria are not subjected to the same filtering action as in a soil where there is even filtration.

Although Israel J. Kligler [2] states that the "pollution of wells is usually surface in origin," the direct pollution through ground water is pointed out in his summary, as follows:

> The problem has been approached both from the experimental and practical standpoint. In the laboratory repeated tests have been made to determine: (1) the viability of the typhoid and dysentery bacilli in soil and in excrement under different conditions; (2) their ability to penetrate through columns of soil of different porosity; (3) their viability in septic fluids and effluents; and (4) the nature of the antagonistic factors in soil and septic material which influence the viability of these microörganisms. In the field work various types of privies of different ages were examined particularly with regard to (1) the extent of pollution of the soil surrounding these privies; (2) their relation to well pollution; and (3) the passage of material from the privies through the soil to adjoining wells.
>
> The main conclusion arrived at on the basis of both the experimental and field observations is *that in moderately compact clay, sand-clay, or sandy soil, free from cracks, the possibility of subsoil pollution of the ground-water is negligible, provided the ground-water level is more than ten feet below the polluted area.*

The following facts were established:

> 1. The typhoid and dysentery bacilli succumb rapidly on exposure to an unnatural environment. (*a*) Both typhoid and dysentery bacilli die out in 1 to 5 days in septic tanks. (*b*) In solid feces the typhoid bacilli may survive for a period of 10 to 15 days, while the dysentery bacilli rarely survive longer than 5 days. The paratyphoid bacilli are the most resistant members of the group; the Shiga dysentery bacillus is the most sensitive. (*c*) The survival period of these organisms in soil is greater than in either feces or septic fluids, and varies particularly with the moisture and reaction of the soil. Temperature effects the viability, but the two main factors normally are moisture and reaction. In moist natural soil of a pH value of 6.6–7.4, the typhoid and dysentery bacilli may be recovered up to 70 days. In the same soil dry, the bacilli are not recovered after 2 weeks. In moist acid soils, pH 4.8–5.4, 90 per cent of the inoculated bacilli die out within the first 10 days, the others may survive as long as 30 days. All the organisms survive longer near freezing temperature (4° C.) than at higher ones (20–37° C.). (*d*) The antagonistic action of soil bacteria on typhoid and dysentery bacilli is due largely to the alkaline reaction resulting from their metabolism. Specific inhibitive substances are, however, elaborated by some soil bacteria, notably *Bacillus fluorescens* and *Bacillus proteus.*

[2] Rockefeller Institute Monograph 15.

2. The spread of pollution from a focal point is limited in scope. (*a*) Typhoid and dysentery bacilli under experimental conditions were not observed to spread laterally to any appreciable extent, although they were carried vertically through a column of 2 feet of porous soil. In denser soil they failed to penetrate through 1 foot. (*b*) In the field, where the subsoil was free from pollution, either near pit privies or near tile pipes from septic tanks, contamination extended downward to a depth of 5 to 3 feet, and laterally only about 3 feet, from the bottom of the pit or tiles. (*c*) Heavy rains or constant dripping of water may carry surface pollution to a depth of 10 feet.

3. Pollution of wells is usually surface in origin. (*a*) There was no correlation between the type or proximity of the privy to the degree of contamination of the adjacent wells. The purity of the well water varied rather with the condition of the well. Driven shallow wells with pumps were, as a rule, free from contamination, while dug wells with pumps or buckets were generally grossly polluted. (*b*) Experiments with fluorescine failed to show subsoil pollution of wells from privies, but proved in some instances at least the possibility of surface contamination.

According to Kligler, F. A. A. F. Eykin and G. Grijns, working in the Tropics, made similar observations. They found very little pollution in the soil around pits not reaching the groundwater level and in only one case traced pollution 5 meters from the pit. *Bacillus coli* was not found at a depth of 20 inches from the bottom of the pit, but during wet weather the penetration was about three times as great. As stated by W. A. Herdenbergh—

In the case of high ground water, these authorities seem to think that much pollution is from the soil directly into the ground water and thence to the well, with the privy having no part in the process. This would appear to fall under the head of surface pollution and illustrates how mechanical (or animal) transportation of pollution may be an important factor in the spread of disease.

The Commission on Additional Water Supply for New York City found that polluted water was rendered safe to use after flowing through 25 feet of fine sand. In abstracting a report of this observation W. A. Hardenbergh states:

The report of the Commission on Additional Water Supply for New York City, made by Burr, Hering and Freeman, records some experiments on the same subject. The tests were made at Elmont, L. I. While it is stated that the passage of polluted water at low velocities through twenty-five feet of the finer sands, such as are found in Long Island, will render the water safe to use, it is also shown that, under severe conditions sewage bacteria and B. coli may pass through soil for a considerable distance. In most cases, a lesser distance than twenty-five feet may be considered safe, it is stated.

Shallow pits if unprotected from surface water, according to the investigations of the Public Health Service at Wilmington, North Carolina, and other observations, are a source of danger. In the work at North Carolina, pits filled with surface or rain water carried pollution to the ground water below, and from pits reaching the ground water *B. coli* traveled a distance of 200 feet.

Most investigators agree that if the ground water is not polluted the chance of infecting wells through the soil is very remote, and that most water supplies are infected from surface pollution. Quoting Hardenbergh:

> Dr. C. T. Nesbitt, at that time Health Officer of New Hanover County, N. C., made a series of tests in 1917 at some mill villages near Wilmington. He found pollution of the ground water from effluents from septic closets, in some cases up to twenty feet from the effluent pipe, beyond which distance he made no tests. The results in this case were generally such as to indicate that the sand-clay soil of that region does not fully protect the ground water from fecal pollution, nor prevent the travel with underground water of such pollution for uncertain distances.
>
> This indication was borne out by the bacteriological examination of about 700 shallow driven wells located in the city and county. The only wells of this kind free from pollution were those located 200 to 500 yards away from any concentrated source of pollution, as stables or privies. The bacterial counts in those wells not so located were extremely high, and the presumptive tests for B. coli were almost unfailingly positive.

I do not have a reprint of the work on these 700 shallow wells, and do not know if there was surface pollution or not, but in many other places a careful examination has revealed surface pollution of most of the wells.

In Manila there are 42 artesian wells from 345 to 900 feet in depth, which are not likely to be contaminated from ground water. Pollution was found in many of these wells, but careful examination showed the possibility of surface pollution. After the concrete platforms around these wells were elevated and the well heads repaired presumptive *B. coli* were seldom found and the bacterial counts were reduced to satisfactory limits. Shallow wells would not have shown such good results. In fact satisfactory water drawn from a depth of 20 feet has never been found in Manila. We have no evidence showing that bored-hole latrines reaching the ground-water level have ever infected a properly constructed deep well. In many villages the cost of numerous shallow wells, which are sources of danger regardless of bored-hole latrines, is greater than the cost of a deep well;

therefore deep wells are recommended where satisfactory piped-in water cannot be obtained.

Rosenau * shows a picture of the "popular idea of how wells become infected from surface pollution," and states, "this rarely takes place in rural districts, as the soil can usually hold back most of the impurities." Similar pictures are shown in many elementary books on hygiene, public-health pamphlets, and posters. It is more reasonable to show direct pollution from the surface where bacteria obviously have easy access to the well.

According to Rosenau, "The viability of typhoid bacilli in feces is very variable, depending on the composition of the feces and the varieties of other bacteria present." Sometimes typhoid bacilli in fæces perish in a few hours, and under other conditions have been found to live five to seven months. The life of the organism in privies and in water is usually comparatively short. "In nature they seldom, if ever, live in water beyond 7 days, and are often dead in 48 hours." They probably live longer in clean water than in contaminated water, but soil polluted on the surface is most dangerous. The deleterious effect of antibiosis, chemicals, temperature, light, dissociation, sunlight, filtration through soil, and other factors affect bacteria.

Rosenau refers to the use of dyes and chemicals to determine the sources of pollution. He regards these tests as valuable in indicating the possibility of danger under certain circumstances and finds them useful in discovering the sources of pollution near wells or in limestone formations. He points out the possibility of error in concluding that microörganisms and dangerous pollution travel an equal distance to the chemicals, stating "the soil has well-known filtering power when free from fissures or open channels and is capable of removing bacteria and oxidizing large quantities of organic matter."

On the other hand Rosenau records the travel of *Bacillus prodigiosus* to a distance of 200 meters in forty-two hours. He does not describe the soil nor state whether or not there was surface travel. The cultures were poured into the ground.

Rosenau cites many examinations under, "interpretation of sanitary water analyses," in some of which there was evidently pollution from soil surcharged with organic matter, and another instance in which there was remote pollution in which organic matter was mineralized and the bacteria held back by the soil,

* Preventive Medicine and Hygiene, page 951.

and a number of wells in which there was direct infection from the surface.

It is believed by many that the *B. coli* and count tests do not give the information required. Some pathogenic bacteria will die where *B. coli* might survive in an acid soil. The cholera vibrio lives best under alkaline conditions. Dr. Otto Schöbl, of the Bureau of Science, Manila, suggested the use of a cholera-like vibrio which is easier to identify than *B. coli* and responds to enrichment in peptone broth. This organism is a much better indicator for cholera than *B. coli,* and work is now under way in the Philippines on the migration problem. Doctors Ramirez and Basaca, of the Bureau of Science, have given much of their time to the bacteriological technic.

In an article, entitled "Well pollution and safe sites for bored-hole latrines," an attempt was made to caution health officers as to the possible danger of installing latrines near shallow wells. This piece of work was not intended as a scientific check on previous bacteriological work on migration that has been published by a number of bacteriologists. The work had to be done in a very limited length of time, and the number of examinations were limited. Latrines were being installed within a few feet of shallow wells, and the experiment showed that bacteria in that area would travel in subsoil water considerably farther than this distance. As stated in the article, "The entire experiment was of such short duration that we make no pretence of presenting a complete piece of work. However, the results give a fair indication of the degree of possible contamination of water-supply situated within short distances of bored-hole latrines in a similar soil." This was only a preliminary piece of work, and it served its purpose until more complete work could be undertaken.

Credit should be given in this article to all persons who have contributed toward the development of the bored-hole latrine, but the names of individuals other than those mentioned are not available.

The three following paragraphs are quoted from a report submitted by Dr. John L. Hydrick to the Rockefeller Foundation:

After the rural hygiene campaigns in Java had been in operation for a few months, the sanitary inspectors noticed that in the areas in which the simple pit latrines were deep enough to reach groundwater the floors of the pits were covered with black sludge and a thick scum floated on the water.

Since the odors of fermentation from these latrines were not more objectionable than those from dry pits, Dr. van Breemen, city health officer of Batavia, decided to carry out some experiments with a type of latrine devised several years ago by one of the field officers of the Dienst der Volksgezondheid in Nederlandsch Indie.

This field officer had noticed that the small borers used on the estates for digging holes for fence posts and telephone poles were easily handled by the laborers and that with very little difficulty holes could be dug to the groundwater level. He suggested that these borers be used to make simple pit latrines, since fecal material deposited in a deep pit which reaches groundwater would undergo fermentation. The action would be similar to that of a septic tank; a narrow deep hole should be usable over a long period of time, and, on account of its small diameter, its walls would be less liable to cave in after heavy rains.

There are published articles on latrine boring that have not yet been received. This publication covers methods developed locally, descriptions furnished by manufacturers, and reports forwarded by Dr. Van Wesep and Mr. Rollin C. Dean, of the Rockefeller Foundation. Dr. Victor G. Heiser has contributed much information and many valuable suggestions at frequent intervals. Many officers in the Straits Settlements and in the Philippine Health Service, especially Dr. Jacobo Fajardo, director of health, and Dr. Gabriel Intengan have given active coöperation in the work. Mr. Cecilio Marcelino has given much of his time in making molds for water traps. We are indebted to Mr. Eugenio Viana, superintendent of San Lazaro Hospital, for his active coöperation in the construction of many preliminary designs of cement slabs, water traps, and other work.

Mr. Mañosa, chief of the Sanitary Engineering Department of the Philippines, and Messrs. Diaz, Claustro, and Bagabaldo have given valuable service in latrine installation.

I am indebted to Dr. William H. Brown, director of the Bureau of Science, Philippine Islands, for editorial suggestions and corrections. Mr. R. C. McGregor, associate editor of the Journal of Science, has rendered valuable aid in editorial corrections of this article; and Macario Ligaya and Francisco Rafael, of the Bureau of Science, have spent a great deal of time redrawing many of the pictures.

ADDRESSES OF MANUFACTURERS AND DEALERS AND WHAT THEY SELL

There are many manufacturers and distributors of boring equipment, but the following list will be sufficient to allow a selection of inexpensive equipment as well as modern up-to-date machinery.

The National Supply Corporation, 120 Broadway, New York City, and 185 Queen Victoria Street, London, E. C. 4., have in stock or can obtain almost anything in boring equipment known.

The Oil Well Engineering Co., Ltd., Cheadle Heath, Stockport, England, and R. Richards & Co., Upper Ground Street, London, S. E., deal in an extensive line of boring apparatus.

Werf Conrad, Drilling Outfits Department, Haarlem, Holland, manufacture the Banka hand drill, which is not practical for bored-hole latrine work, but they have derricks, a variety of augers, chain tongs, and many useful accessories.

The Ingersoll-Rand Company, 11 Broadway, New York, manufacture an enormous variety of power-driven machinery that will drill anything. They sell the "calyx" hand-power geared outfit that can be equipped with a clay auger to bore 16-inch holes. This apparatus sells for about 1,750 dollars. They also sell drills for making blast holes in rock.

The Keystone Drill Company, Beaver Falls, Pennsylvania, with offices at 170 Broadway, New York, manufacture a large variety of power drills, and numerous types of clay augers, sand pumps, bailers, rock drills, and other equipment.

The Star Drilling Machine Company, Akron, Ohio, manufacture portable well-drilling machinery, confined to the churn or percussion-type drill, which is not practical for latrine boring. They manufacture many types of auger bits and accessories.

The Okell-Well Machinery Corporation, 2035 Bay Street, Los Angeles, California, quote a price of 1,798.91 dollars for a complete boring machine including a seven-horse-power motor and a full line of accessories.

R. R. Howell & Co., Minneapolis, Minnesota, are manufacturers and jobbers of a full line of drilling machinery, augers, and supplies.

Sweeney and Gray Co., Inc., 81 Sixth Street, Long Island City, New York, manufacture boring equipment, and sell a clay auger with a hinged bottom for about 100 dollars. The shafting costs 40 dollars.

The Specialty Device Co., 106 West Third Street, Cincinnati, Ohio, manufacture the "Standard" earth auger discussed in this paper, a quadruple expansion brace for holding the shaft, and other useful accessories. These products are sold through the A. J. Alsdorf Corporation, 330 South Franklin Street, Chicago. The No. 10 auger equipped with extension blades costs 6.60 dollars. The brace costs 4 dollars. A 25-foot coupled shaft costs 3.75 dollars. Couplings and bolts cost 2 dollars.

Lang-London-Ltd., 34 Gray's Inn Road, Holborn, London, W. C. L., sells the Lang earth borer discussed in this paper.

Iwan Brothers, South Bend, Indiana, manufacture the Iwan post-hole auger, disk auger, and sand-digging tools. These augers can be purchased from the National Supply Co., 185 Queen Victoria Street, London, and from Lindeteves-Stokvis, Amsterdam, Holland; Batavia, Java; and Penang, Straits Settlements.

The Budda Company, Harvey, Illinois, with an export office at 30 Church Street, New York, manufacture the Budda-Hubron machine. The trailer-type machine for boring holes 20 feet deep costs 2,275 dollars and the truck-mounted type costs 2,125 dollars. This is the most compact power-driven machine on the market.

The Gus Pech Foundry and Mfg. Co., 200 Second Avenue, S. W., Le Mars, Iowa, manufacture a practical machine-driven auger, the No. 2 Monitor mounted boring machine, and a variety of auger bits, stone hooks, and other accessories that are valuable in latrine construction.

The Howells Mining Drill Co., Plymouth, Pennsylvania, manufacture the twist drill illustrated in this article, which has been especially adapted to our work for drilling blast holes in adobe, shale, and other hard formations. They also make the hand geared machine known as Howells prospector's drill, which should be equipped with bits to bore 1-inch by 2½ foot blast holes at variable depths up to 18 feet, and the weighted tripod regularly furnished or the stand used on their Spry Little Giant slate drill. They also make air and electric drills.

Oilwell Supply Co., London, and 215 Water Street, Pittsburg, Pennsylvania, sell all kinds of boring apparatus.

Armstrong Mfg. Co., Waterloo, Iowa, sell a large variety of drills.

McKiernan-Terry Drill Co., 115 Broadway, New York, sell many kinds of drilling apparatus.

EQUIPMENT AND WHERE TO OBTAIN IT

	Dollars United States currency.
Iwan post-hole auger bottom, 14-inch (dozen)	67.20
Iwan post-hole auger bottom, 16-inch (dozen)	81.60
Iwan post-hole auger bottom, 16-inch, extra heavy blades (each)	12.50
Iwan Bros., South Bend, Indiana.	
National Supply Corporation, England.	
Lindeteves-Stokvis, Amsterdam, Holland; Batavia, Java; and Penang, Straits Settlements.	
Chain tongs, 2½-inch Vulcan bijaw (each)	3.50
J. H. Williams and Co., Brooklyn, New York. National Supply Corporation, New York and England.	
Nearly all local hardware stores.	
Pulleys (each)	1.00
Local stores.	
Wilson pipe wrench (each)	15.00
National Supply Corporation.	
Drop-bottom double-bit augers for earth, sand and gravel, 16-inch (each)	45.00
Gus Pech Manufacturing Company.	
National Supply Corporation.	
Okell-Well Machine Corporation.	
R. R. Howell and Co.	
Sweeny and Gray Company.	
Clay auger, 15⅝-inch, No. 1, with 20-foot boring rods (each)	95.00
R. Richards and Co., London.	
Clay auger, 14- and 16-inch drop bottom.	
R. R. Howell and Co.	
Gus Pech Manufacturing Company.	

	Dollars United States currency.
Lang earth borer, 14-inch, complete with sand-boring attachment and accessories (each)	96.00
Lang-London, Ltd., England.	
"Standard" auger No. 10, 10-inch, with cutters complete with 20 feet of shaft (each)	10.35
A. J. Alsdorf Corporation.	
The Gus Pech or No. 2 Monitor boring machine (each)	842.50
Gas Pech Manufacturing Company.	
National Supply Corporation.	
Okell-Well Machine Corporation.	
The Budda-Hubron machine (each)	2,275.00
The Budda Company, Harvey, Illinois.	
Hand-twisted drills, geared drills, electric- and air-driven drills for making blast holes in shale, slate, adobe rock, laterite, and other hard formations.	
Howells Mining Drill Works, Plymouth, Pa.	
Machine-driven rock drills for making blast holes in hard rock.	
Ingersoll-Rand Company.	

Drill steel for making bars is sold by local dealers and by Ingersoll Rand who carry in stock a large supply of standard sizes and shapes such as hexagon, round, square, pentagon, cruciform solid, and twisted concave. They also have finished sets of drill steel.

SUMMARY

The Iwan post-hole auger with locally made shaft and turning handles, an inverted V hoisting frame equipped with a compound pulley and a shaft supporting brace or hinged-door platform is recommended as the cheapest fast-cutting equipment for boring latrines in all soils except hard formations, silting sand, and soft mud.

Various shafts, turning handles, braces, hoisting equipment, and miscellaneous accessories are discussed.

Useful augers for general boring including very soft soil are the locally made augers, the auger used by the United Fruit Co., and a large number of augers on the market.

Useful augers for boring in very soft soil and silting sand are the locally made augers with hinged blades, the augers used by the United Fruit Co., the Iwan augers equipped with locally made valves, the Lang augers, and a variety of bailers, pumps, and other augers regularly supplied by dealers.

A number of hinged shafts to facilitate dumping are shown. The method of preventing caving of the latrine walls while boring in mud and quicksand is described.

A rapid practical method of installing latrines in tuff, or so-called adobe rock, and other very hard formations is described.

The method described has been used successfully since October, 1929.

Power-driven drilling machines are recommended for rapid economical boring where large numbers of latrines are to be installed and there is sufficient space for the operation of the machines.

Linings to prevent caving of the walls of bored latrines and the methods of using linings in silting formations are described.

Water traps made locally of baked clay or cement, which greatly improve the bored-hole latrine, especially where the ground-water level is near the surface, have been used successfully. These traps are described and illustrated.

A variety of cement slabs and a metal latrine floor are recommended.

The details of building superstructures are not given, but the importance of constructing the slabs and walls so that no uncovered earth is exposed to contamination is emphasized.

A brief description of bacterial migration is useful in locating safe sites for bored-hole latrines.

Dr. Victor G. Heiser suggests emphasis on proper supervision so that bored latrines are not installed in places where there is danger of infecting domestic water supplies.

A list of manufacturers and dealers with their addresses and the materials they sell that are useful for making bored-hole latrines is included.

A list of bored-hole latrine boring equipment, where to obtain it, and the prices are given.

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U. S. Public Health Service Reports.

ILLUSTRATIONS

FIG. 3. Crumbie tongs, one of the most satisfactory inexpensive tongs on the market. *a*, Old type; *b*, improved Crumbie tongs; these cost a little more, but are worth it.

4. Turning handle designed by Doctor Hamilton. "The two steel retention plates with the grooves on their inner surfaces serve to prevent the dogs from falling out of place when no pipe is between them. The plates are bolted together and to the frame of the body so that the dogs are easily removable and exchanged when worn or damaged." (Drawing from a sketch sent by Doctor Hamilton to the Rockefeller Foundation.)

5. Turning handles. *a*, The pipe-cross turning handle. This outfit is usually used in the Philippine Islands for general distribution because it is the least expensive satisfactory device we have tried. The only materials required are two pieces of pipe, a heavy cross or four-way joint, and a tool-steel pin to transfix the cross and shaft. The cross slides easily up or down the shaft; *b*, a turning handle for use on a shaft drilled with holes to engage the lugs. This wrench is more expensive than the pipe-cross handle.

6. Coupling and shaft. *a*, A solid coupling for shafts made in sections; two bolts are removed to take the shaft apart; *b*, the bolt shaft, one of the most useful shafts we have used. This shaft stands more rough use than any other shaft tried. Permanent bolts or rivets transfix the shaft at 3-foot intervals. The turning handles never damage this shaft. The bolt heads act as lugs for the handles to push against.

7. Turning handles. *a*, One type of locally made turning handle for the bolt shaft, hammered out by a blacksmith. These can also be made of cast iron; *b*, another type of locally made handle for the bolt shaft. The head of a bolt on the shaft enters the socket *r*, and the nut on the opposite end fits into notch *n*; *c*, a turning handle that can be made locally or purchased ready-made from dealers.

8. A more elaborate turning handle for use on the bolt shaft. This is an excellent handle but costs 20 pesos to make locally. In large quantities the cost should be less.

9. The A frame now used instead of a tripod for hoisting augers. The guy ropes are usually tied to a house, tree, or fence post. Bamboo is usually used because it is much cheaper in the Philippines than iron pipe.

10. In some places augers are lifted by direct pull, but the job is too heavy in most areas. The rope is attached to the arch or low down on the shaft.

11. Trap doors costing 6 pesos greatly facilitate boring. The auger shaft is supported by the doors when closed. Stakes can be driven into the earth at the notched corners to prevent movement of the platform while turning. One of these platform braces is now included as standard equipment with every auger used in the Philippines.

FIG. 12. This tripod is more difficult to transport than the A frames, but if properly made greatly speeds up boring when several holes are to be bored within a small area. *a*, Shaft support. A knock on the extension lever *c* releases the auger so that it can be swung away to be emptied; *b*, an iron hook that is a great time and energy saver. These hooks hold the auger away from the latrine while being emptied. The hooks are also used on A frames.

13. An excellent shaft brace designed by Doctor Hamilton. The cost of production is a disadvantage of this device. (Drawing from Doctor Hamilton's sketch.)

14. A quadruple expansion brace sold by the Alsdorf Corporation. The stock size is made to fit the Standard earth auger.

15. A locally made swivel for use on the top of the shaft. We have used these swivels but prefer unhooking the rope from the shaft while turning the auger.

16. Devices which can be attached to the auger shaft and adjusted to any position so that a hook on the hoisting rope can be quickly hooked on instead of tying and undoing knots; *a* and *b* are used on shafts with holes drilled at intervals such as used with the pipe-cross handles; *c* and *d* are used on the plain or bolt shafts.

17. Reamer, stone hooks, and grapple. *a*, An undercutting reamer which is useful in cutting away the sides of latrines below linings; fortunately it is rarely necessary to use one of these; *b* and *c*, stone hooks which are useful in removing small bowlders; *d*, a grapple (redrawn from picture from R. R. Howell & Co.).

18. Augers suitable for soft mud and silting sand. *a*, Type made by many manufacturers of drilling equipment; *b*, a heavy dumping auger such as used with machine-driven outfits; this auger is made by the Gus Pech Co.; *c*, the Lang auger with sand-boring screw; this is a good hand auger for boring in sand. See fig. 31, Howell drop-bottom auger.

19. Sand pumps and bailers which can be purchased from dealers. These pictures are from the Keystone Drilling Co., Beaver Falls, Pa.

20. The Iwan post-hole auger fitted with valves for use in silting sand.

21. A hinge to facilitate turning an auger over so that it can be dumped.

22. A hinge to facilitate turning an auger over so that it can be dumped.

23. A hinge for the same purpose as those shown in figs. 21 and 22.

24. An auger designed by A. L. Savignac for the United Fruit Co. This auger works in soft mud. Note the hinge for dumping.

25. A clay and sand auger that can be made locally. Augers of similar design are sold by many manufacturers without the flap valve *a*. R. R. Howell & Co., Minneapolis, manufacture these augers. A hinge on the shaft is not needed because the bottom of the auger swings back on a hinge to empty the contents.

FIG. 26. A valve auger designed by Doctor Hamilton in Java.

27. A short chisel-bottom bailer designed by the engineering department, Sarawak Oil Field, Ltd., Miri, Sarawak. This drill should be a good one, but is expensive to make and requires six men to handle effectively.

28. Disc augers. These are probably the cheapest augers made, but are not as good as other augers mentioned.

29. The Standard auger, sold by the A. J. Alsdorf Corporation.

30. The Lang-London, Ltd., auger. This auger is used in many places in clay and especially in soft sand. When used in sand a special screw, shown in fig. 18, *c*, is attached.

31. Various earth augers manufactured by R. R. Howell & Co. *a*, For clay and hard pan; *b*, for boring and removing core; *c* and *d*, for general boring; *e*, for loosening and removing stones; *f*, for loose sand soil; *g*, a drop-bottom, fast-cutting auger especially useful with power-driven machines; *h*, a spudding jetting drill used in rock drilling. Blasting is much more rapid for latrine installation in rock.

32. Animal-driven boring apparatus. Used for many years in well drilling, but not suitable for rapid latrine boring.

33. The Budda-Hubron machine drill. This is an efficient rotary drill, and takes less operating space than any machine we have heard of. It can be used for boring in clay, sand, hard pan, shale, and frozen ground. The stock machine bores holes 10 feet in depth, but the manufacturers will equip it for boring 20-foot holes. It costs about 2,400 dollars United States currency.

34. The Gus Pech power-driven machine is a rapid borer, but requires a space 10 by 16 feet for efficient operation. It costs less than 1,000 dollars equipped for latrine boring.

35. Tools used for blasting latrines in rock. *a*, Bar used in drilling blast holes in tuff, adobe rock, and other hard formations; *a 3*, drill used with hammer for making blast holes in hard rock; *b*, crow bar used for starting latrine or straightening side; *c*, long bar used occasionally in deep latrines; *d*, bamboo bucket for removing water from blast holes; *e*, bamboo brush for cleaning mud out of blast holes.

36. Blasting in rock. *a* to *e*, Positions of blast holes. In hard rock five blast holes are drilled at *a* and *b*.

37. A hand drill especially designed for making blast holes in tuff, adobe rock, shale, or other hard formations. It will not cut hard rock. This drill cuts the holes rapidly and cleans them out at the same time; it is constantly used now in place of the bar *a*, fig. 35, except in the hardest rock where the drill *a*3 is used. Manufactured by the Howells Mining Drill Co., Plymouth, Pa. Cost about 18 dollars.

38. A geared drill for boring blast holes rapidly in very hard formation except hard rock. Manufactured by Howells Mining Drill Co., Plymouth, Pa. Cost, 140 dollars.

FIG. 39. Derrick manufactured by Werf Conrad, Haarlem, Holland. For rotary, percussion, or free-ball system of boring. This apparatus will handle heavy drills. It is too heavy for general bored-latrine work.

40. Hand-power spudding and hoisting windlass manufactured by Werf Conrad, Haarlem, Holland. Believed to be too expensive (about 200 dollars) and too bulky for general distribution for latrine boring.

41. Woven-bamboo cylinder partly made. This makes a very satisfactory latrine lining in most places. The section *a* is a temporary support to keep the ribs straight while weaving; *b* is an enlarged section of the woven-bamboo latrine lining.

42. Various latrine linings. *a*, A galvanized-iron wire-net lining which can be used in places where white ants eat the bamboo or where bamboo is not available; *b*, stove-pipe double wall, "wall method" of making a lining. In ordinary soils numerous holes can be cut into the metal to allow better action. In silting soils the sections are added one at a time as boring proceeds. A few dents hold the cylinders together; *c*, four to six empty metal oil or tar drums placed end on end are frequently used as linings for latrines. The heads of the drums are cut out with a chisel. Wooden or metal strips are nailed to the drums to make strong joints. These are often used in silting sand.

43. A steel latrine floor, or squatting plate, designed by Dr. W. P. Jacocks for use in Ceylon. The cost is about 4 rupees, about 2.60 pesos.

44. Latrine and water closet. *a*, The bored-hole latrine complete with superstructure. The lining and cement casing are not used in soil that does not cave into the latrine. Metal drums are usually used instead of cement casings where the water rises to the surface; *b*, a cement water closet that can be flushed with a bucket of water. About two hundred of these water traps are giving excellent service in the Philippines. Note clean-out hole in Plate 3. The sloping foot rests make the user sit on the water closet correctly. The rests throw one off balance if he attempts to squat backwards. These traps cost about 4 pesos each. They absolutely eliminate fly and mosquito breeding and foul odors.

45. Reënforced concrete slab for use with water trap. Elevated type.

46. Latrine equipped with water trap sunk flush with the slab. This trap costs only 3 pesos. Note the sloping foot rests and the small vent, which can be opened to relieve pressure in an air-tight latrine. The washings from the trap fall from the lip and do not follow the trap down to the wall of the latrine.

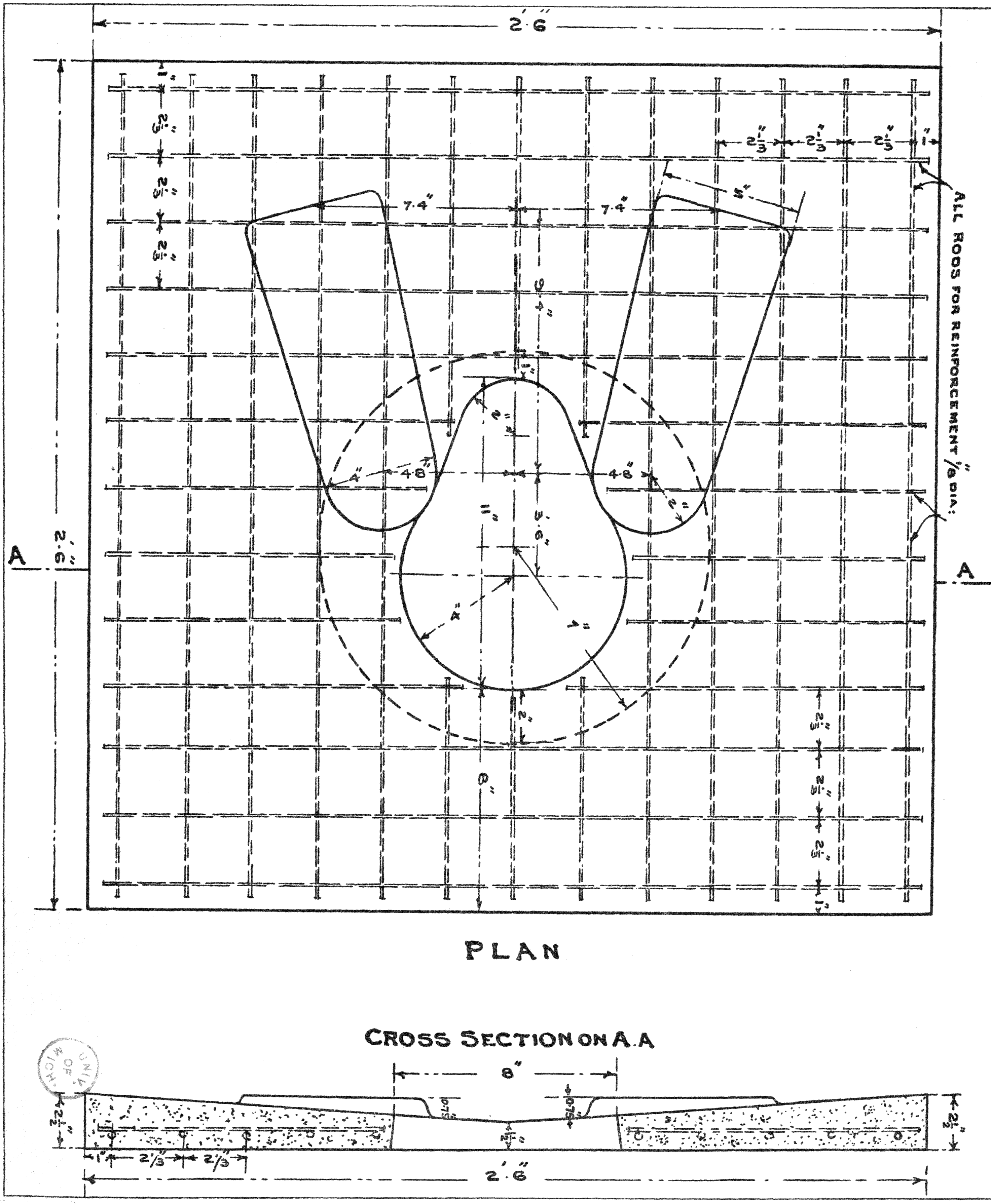

ALL RODS FOR REINFORCEMENT 1/8" DIA.
2' 6"
PLAN
CROSS SECTION ON A.A
A
A
8"
2' 6"

PLATE 1.

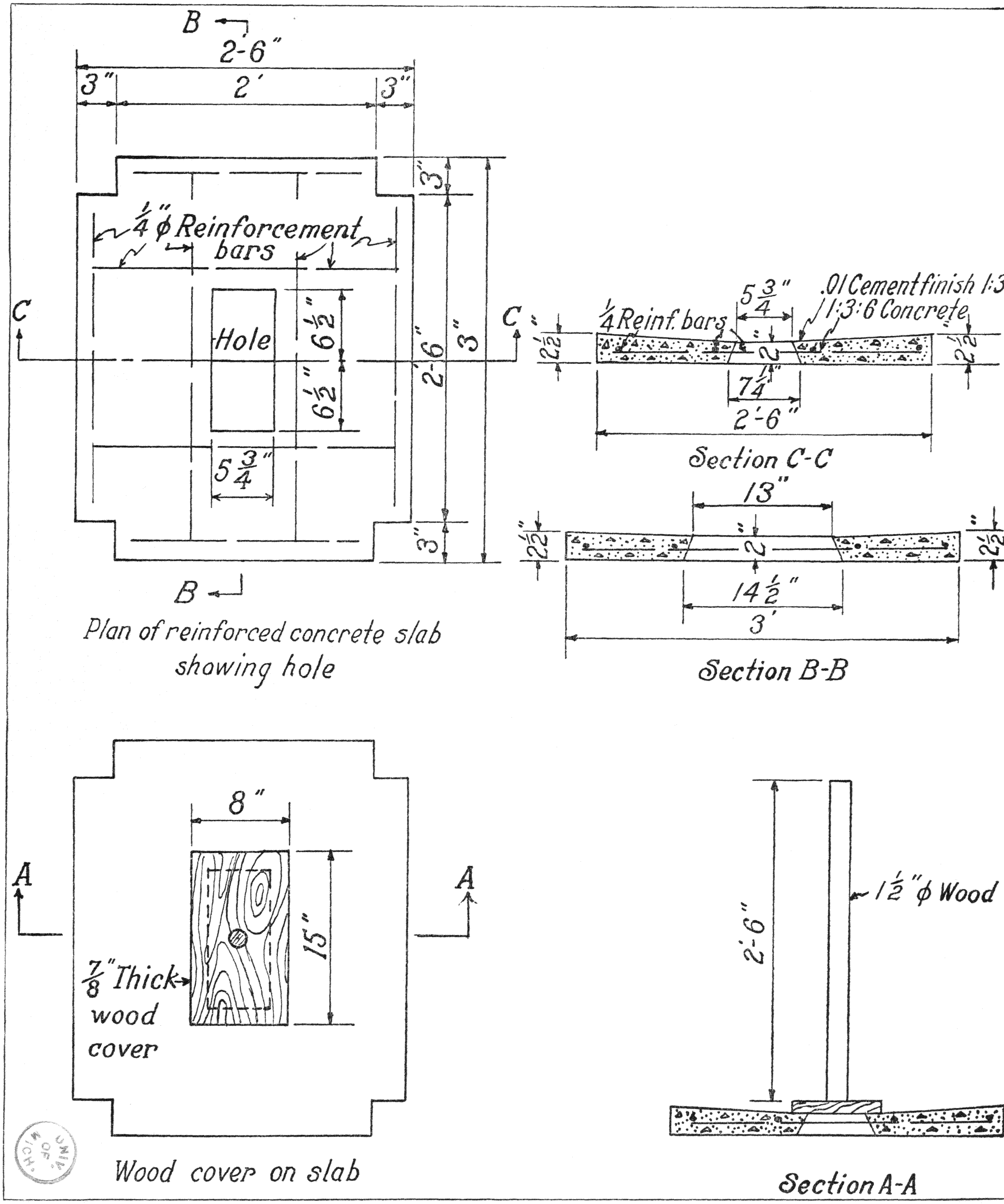
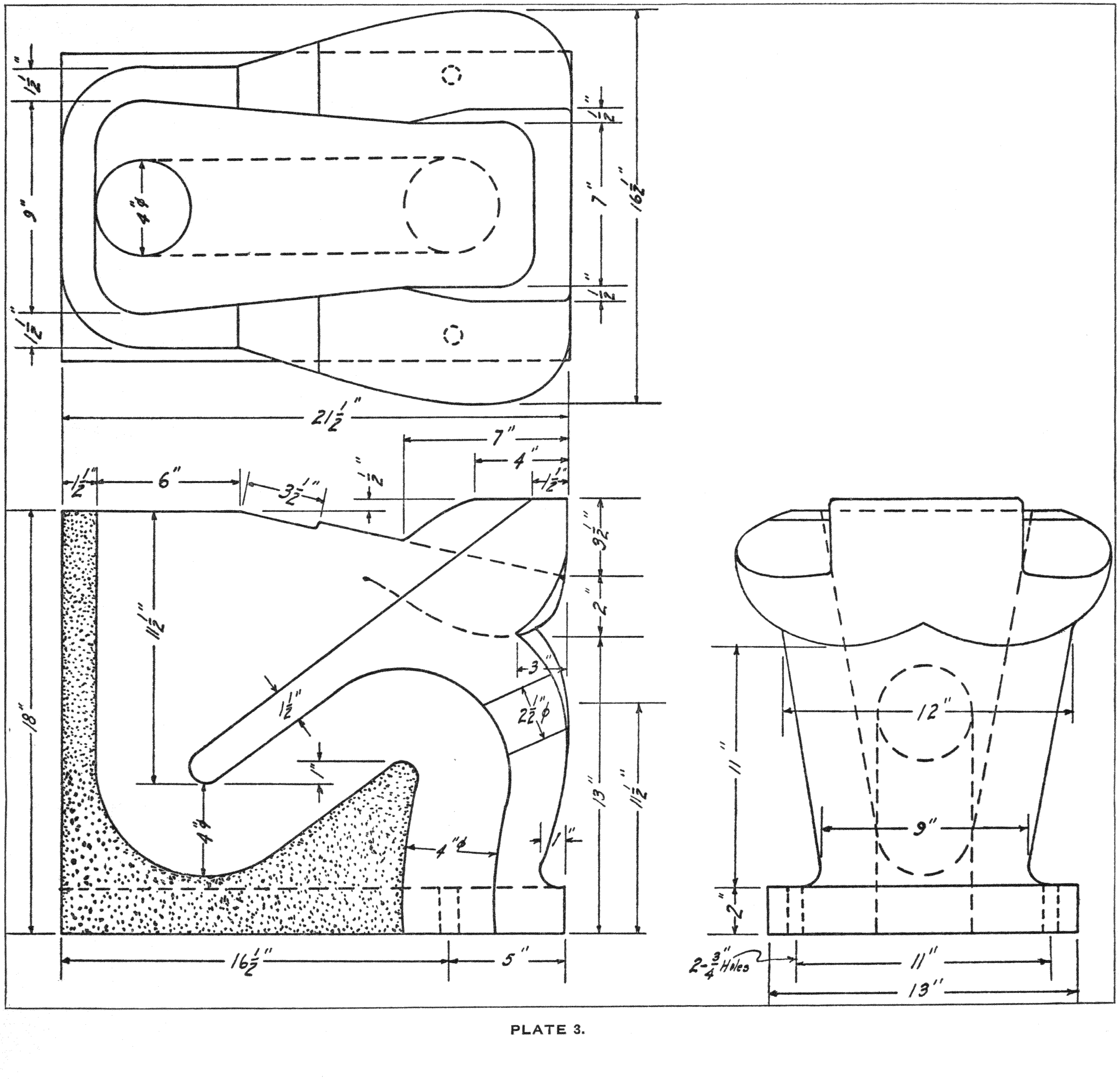
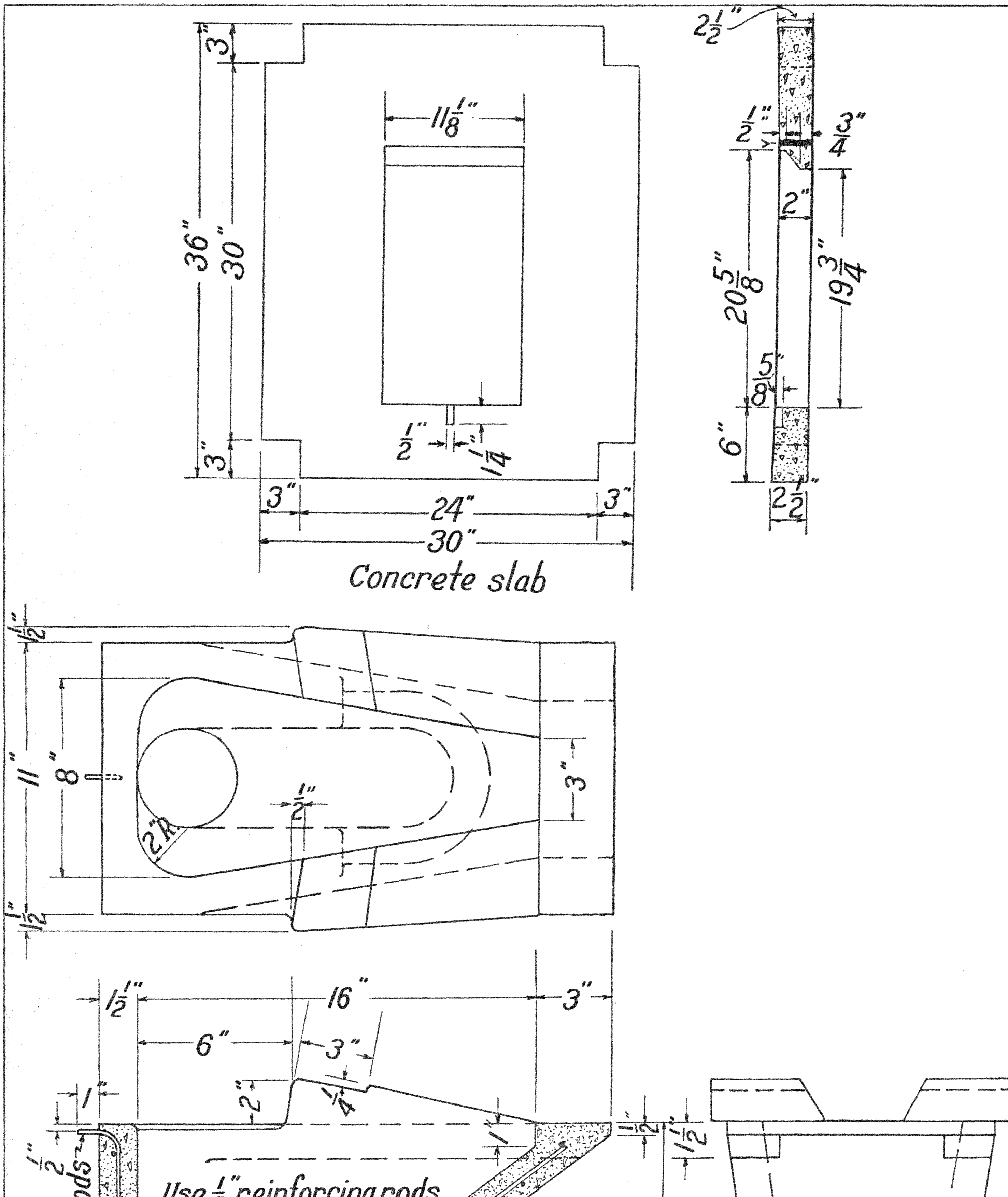

B
2-6"
3"
2'
3"
$\frac{1}{4}$" ϕ Reinforcement bars
C
Hole
$6\frac{1}{2}$"
$6\frac{1}{2}$"
$5\frac{3}{4}$"
2'-6"
3'
3"
3"
C
B
Plan of reinforced concrete slab showing hole
$\frac{1}{4}$ Reinf. bars
$5\frac{3}{4}$"
.01 Cement finish 1:3
1:3:6 Concrete
$2\frac{1}{2}$"
2"
$7\frac{1}{4}$"
2'-6"
Section C-C
13"
$2\frac{1}{2}$"
2"
$14\frac{1}{2}$"
3'
Section B-B
8"
A
A
15"
$\frac{7}{8}$" Thick wood cover
Wood cover on slab
2'-6"
$1\frac{1}{2}$" ϕ Wood
Section A-A

PLATE 2.



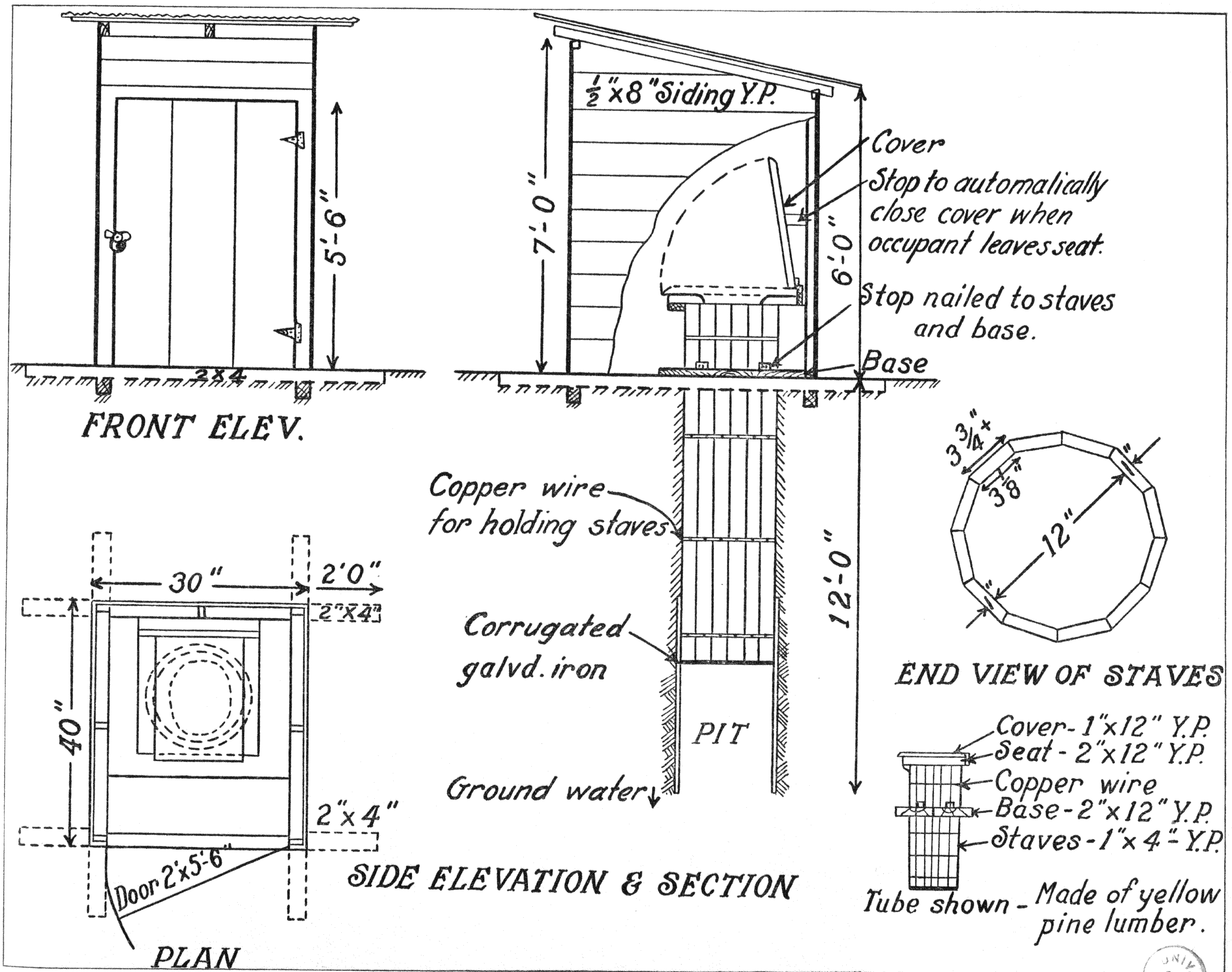
1 1/2"
9"
1 1/2"
4"φ
1/2"
7"
1/2"
16 1/2"
21 1/2"
7"
4"
1/2"
1/2"
6"
3 1/2"
1/2"
9 1/2"
2"
13"
11 1/2"
18"
11 1/2"
1 1/2"
1"
4"φ
3"
2 1/2"φ
4"φ
1"
16 1/2"
5"
12"
11"
9"
2"
2-3/4" Holes
11"
13"

PLATE 3.



36"
30"
3"
3"
$11\frac{1}{8}$"
$\frac{1}{2}$"
$\frac{1}{4}$"
3"
24"
3"
30"
Concrete slab
$2\frac{1}{2}$"
$\frac{1}{2}$"
$\frac{3}{4}$"
2"
$20\frac{5}{8}$"
$19\frac{3}{4}$"
$\frac{5}{8}$"
6"
$2\frac{1}{2}$"
$\frac{1}{2}$"
11"
8"
$\frac{1}{2}$"
3"
2"R.
$\frac{1}{2}$"
$\frac{1}{2}$"
16"
3"
6"
3"
1"
2"
$\frac{1}{4}$"
1"
$\frac{1}{2}$"
$\frac{1}{2}$"
$1\frac{1}{2}$"
Use $\frac{1}{4}$" reinforcing rods
One of the reinforcing rods
10"
$1\frac{1}{2}$"
4"φ
1"R.
1"
4"φ
$6\frac{1}{2}$"
7"
4"

PLATE 4.



2x4
5'-6"
FRONT ELEV.
½"x8" Siding Y.P.
7'-0"
Cover
Stop to automatically close cover when occupant leaves seat.
6'-0"
Stop nailed to staves and base.
Base
Copper wire for holding staves
Corrugated galvd. iron
12'-0"
PIT
Ground water
3¾"+
⅜"
12"
END VIEW OF STAVES
30"
2'0"
2"X4"
40"
2"x4"
Door 2'x5'-6"
PLAN
SIDE ELEVATION & SECTION
Cover- 1"x12" Y.P.
Seat - 2"x12" Y.P.
Copper wire
Base - 2"x12" Y.P.
Staves - 1"x 4" Y.P.
Tube shown - Made of yellow pine lumber.

PLATE 5.

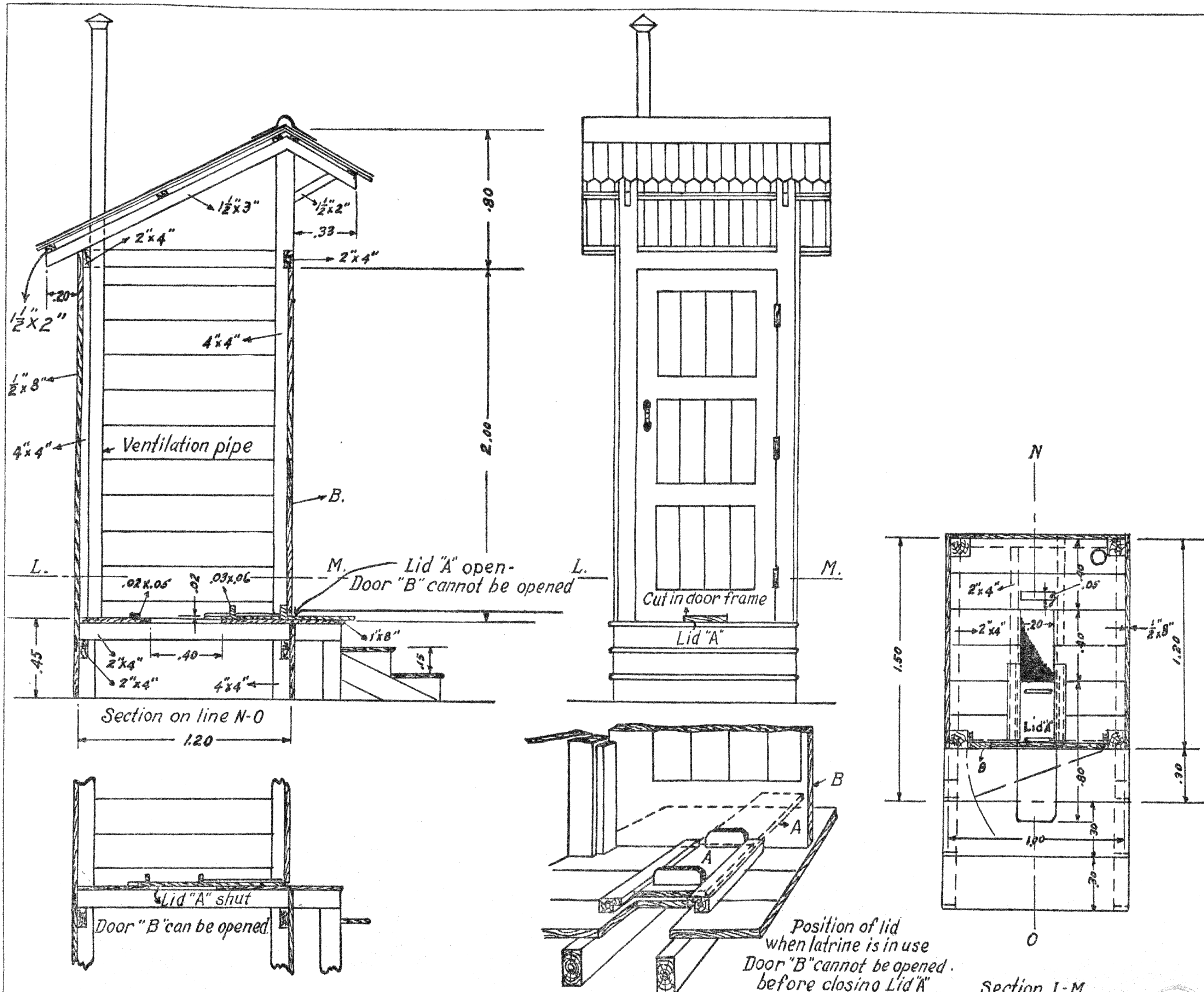
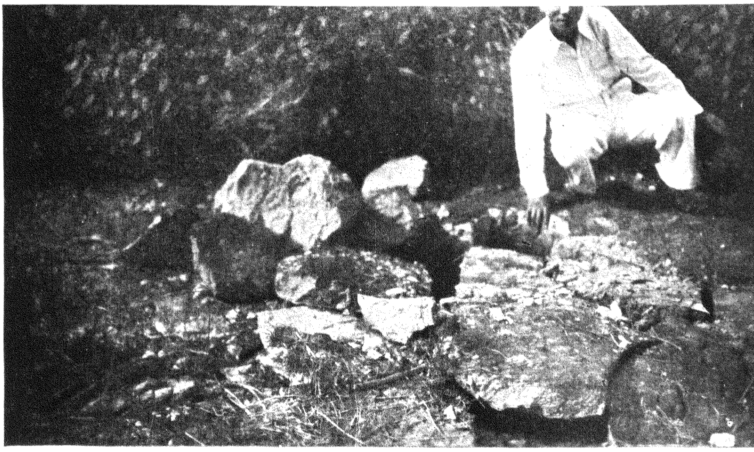
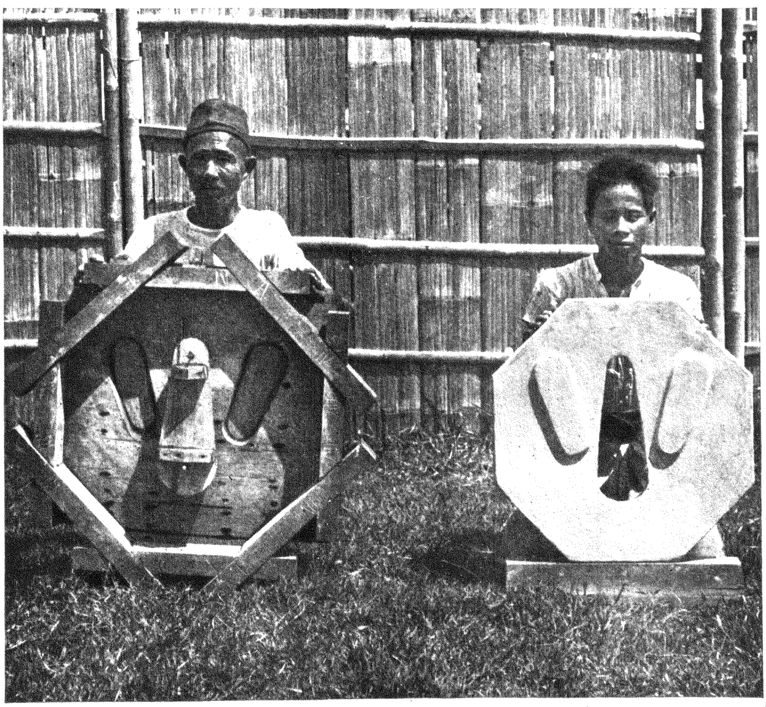

Ventilation pipe
Lid "A" open-
Door "B" cannot be opened
Section on line N-O
Lid "A" shut
Door "B" can be opened
Cut in door frame
Lid "A"
Position of lid
when latrine is in use
Door "B" cannot be opened
before closing Lid "A"
Section L-M

PLATE 6.



1



2

PLATE 7.

THE PHILIPPINE VARIETIES OF ANOPHELES GIGAS AND ANOPHELES LINDESAYI

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TWO PLATES

Anopheles formosus was described by Miss Ludlow in 1909 from a specimen collected at Camp John Hay, Baguio, Benguet, on Luzon Island. It was later considered by Christophers to be a variety of *Anopheles gigas* Giles. The species has not since been reported from the Philippines and the larva has not previously been described. The following description of this stage is based on an examination of 35 larvæ collected in the same locality in April and May, 1929, and in May, 1931. One of the three collections, that of May, 1929, was made for me by Sergeant J. F. Rhodes, of the United States Army Medical Corps. The larvæ were taken at an altitude of about 4,700 feet.

ANOPHELES GIGAS var. FORMOSUS Ludlow, 1909.

Larva.—Inner anterior clypeal hairs (Plate 1, fig. 1) usually simple but occasionally split into two, the bases close together; the outer clypeal hairs one-half or more the length of the inner and branched two to six times, sometimes simple; posterior clypeal hairs nearly as long as the outer and somewhat closer together, branched toward the base from three to eight times, the usual number four or three. Occipital hairs large, the inner branched from four to twelve times, usually from eight to ten; the outer branched from seven to sixteen times with counts of nine, ten, or eleven the most frequent. Inner anterior submedian thoracic hair with three to ten branches; middle anterior hair much longer with from eight to fifteen branches (Plate 1, fig. 3). Palmate hairs lacking on the thorax and first two abdominal segments, being represented by ordinary branched hairs, the one on the thorax with four to ten branches (Plate

[1] In coöperation with the Bureau of Science and the Philippine Health Service.

1, fig. 5). Well-developed palmate hairs present on abdominal segments III to VII, the individual leaflets more or less bluntly tapered, without filaments, and either smooth or with a few serrations on the edges (Plate 1, fig. 7). All of the antipalmate hairs (hair 2 of Martini, 1923) multiple, those on segments III to VII having from three to eight branches with five the most frequent number; antipalmate hair on segment II with from four to eleven branches, seven and eight being the most frequent. The long lateral hairs on abdominal segments IV and V usually 3-branched but vary from two to five in the series; this hair lacking on segment VI and is represented by a very short, branched tuft. Pecten (one specimen) with six long and fifteen short teeth.

The larvæ were collected at the grassy margins of pools in stream beds and on one occasion along the edge of a large rock in a well-shaded stream pool.

Adult females reared from Baguio larvæ agree in general with Ludlow's original description except that the fringe spot on the posterior margin of the wing occurs between veins 5.2 and 6 instead of between the forks of the 5th vein as stated. The type specimen now in the United States National Museum in Washington has it in this position also so that the original description was in error.

The palpi have three very narrow white bands and the apex is more or less pale, some specimens having distinct yellowish scales, others only pale apical hairs. The 6th vein of the wing has a white scaled area two or three times the length of the apical dark spot, the subapical costal white spot is absent and the extreme base of the costa is white (Plate 2, fig. 1).

Slight differences in adult markings have been given for the several varieties of this species, and Christophers (1931) has recently published a revised summary of the group. The varieties recognized, are:

Anopheles gigas Giles, 1901, type form from southern India.

Var. *formosus* Ludlow, 1909, from Luzon, Philippine Islands (not Formosa as listed by Christophers).

Var. *simlensis* James, 1911, from the Western Himalayas.

Var. *refutans* Alcock, 1913, from Ceylon.

Var. *baileyi* Edwards, 1929, from Western China, Eastern Himalayas, Assam, Burma and Tibet.

(*Anopheles edwardsi* Yamada, 1924, from Japan, is considered a distinct species.)

The Philippine form appears, from palpal and wing markings, to resemble variety *refutans* more closely than any of the others.

Both have pale-tipped palpi and the wings are without fringe spots except in the area between veins 5.2 and 6. The two forms probably differ in the scaling of the extreme base of the costa, which Christophers shows to be dark scaled in variety *refutans*. He also records the occurrence of this character in variety *formosus*, but all Philippine specimens examined by me have a white scaled area at the extreme base of the costa, nearly equal to or longer than the succeeding (inner accessory) dark spot, as shown in the accompanying illustration.

The larval characters of the Ceylon form so far as given by Carter (1925) also appear to be similar to those of the Philippine variety except that the post-clypeal hairs are said to be simple or with two or three divisions, whereas none of the specimens examined in this series of var. *formosus* have hairs with less than three branches.

Male genitalia of var. formosus (Plate 2, figs. 3 and 5).—Inner parabasal spine of side piece broad and flattened for entire length, about 0.11 mm long; outer spine 0.14 mm long, more slender and tapered to a long point. Outer lobe of harpagones (claspette) with five to seven unfused spatulate filaments or blades, the internal one somewhat longer than the others, arising from a separate prominence. Length of latter 0.11 mm and the longest one of the others 0.09 mm. The individual blades are bluntly rounded and end in a minute thornlike point. On the inner lobe of the harpagones a group of three hairs placed close together, the outer 0.09 mm long, the middle one very short and the inner one, at the apex of the lobe, 0.14 mm long. In one of three specimens examined, the middle hair on one side is also long. Mesosome (theca) with five to seven leaflets, the longest one about 0.05 mm, the others progressively shorter. Under high magnification most of the leaflets show serrations. The ventral processes of the 9th segment are not apparent except possibly as small humps.

The genitalia of the Philippine variety appear to differ slightly from that of *A. gigas* as described by Christophers (1915) in the hairs of the harpagones and in the ventral processes of the 9th segment.

ANOPHELES LINDESAYI var. BENGUETENSIS var. nov.

A collection made for me by Sergeant Rhodes at Camp John Hay in May, 1929, contained, in addition to larvæ of *A. maculatus* and *A. gigas* var. *formosus*, several specimens of this species, which is the first record of its occurrence in the Philippines. Sergeant Rhodes said that the larvæ were collected along the

edge of a well-shaded stream among leaves and débris or at the side of rocks. Additional collections in the same locality have been made by Mr. F. E. Baisas during 1930 and by myself in May, 1931.

Adults of *A. lindesayi* have unbanded palpi and tarsi and are readily identified by the presence of a broad white band on the distal half of the hind femora. The wing markings of the female of the Philippine variety are shown in the accompanying illustration (Plate 2, fig. 2). The white-scaled spots at the tips of veins 4.2, 5.2, and 6 and the fringe spot at 5.2 are evidently constant, being present in each of the seventeen specimens examined. No white scales occur at the ends of veins 2.2, 3, 4.1, or 5.1. The wing fringe opposite veins 6 and 4.2 is variable and may be either dark or slightly pale.

The markings of the wing are therefore slightly different from any of the varieties of this species as listed by Christophers (1931). The forms recognized by him are:

A. lindesayi[2] Giles, 1900, type form, from the Himalayas.
Var. *japonicus* Yamada, 1918, from Japan.
Var. *pleccau* Koidzumi, 1920, from Formosa (provisionally retained).
Var. *nilgiricus* Christophers, 1924, from South India.
Var. *cameronensis* Edwards, 1929, from the Federated Malay States.

The Philippine form probably comes closest to var. *japonicus*. The scaling at the termination of the veins in the latter variety is, however, considerably more variable. Yamada (1924) notes the occurrence of white spots at the ends of veins 3, 4.2, 5.1, 5.2, and 6 and adds that those at 3, 4.2, and 5.1 may or may not appear according to the specimens. Fringe spots also may or may not occur opposite veins 4.2, 5.1, and 5.2.

The fore and mid femora of the Philippine specimens have distinct white bands or rings at the base, equal to or less than the diameter of the femora in extent. The bands on the hind femora are variable but usually wider. In a number of specimens the ventral white is two to three times the diameter of the femoral joint and the dorsal white somewhat shortened (one to two times the diameter.) In certain specimens the white is practically the same above and below, while in two specimens the black scaling extends nearly to the base above and the white scaling ventrally is more extensive—between one-fifth and one-sixth of the length of the femora by measurement in one speci-

[2] Named after Captain Lindesay but originally spelled *lindesaii*. The changed spelling followed here was made, I believe, by Blanchard in 1905.

men. The arrangement of white seems to be more of less similar to that of var. *cameronensis*, but, according to Christophers, that form has none of the wing veins from 2.2 to 5.2 white-tipped.

Male genitalia.—Inner parabasal spines stout, flattened and recurved, 0.10 mm long (one measurement); outer stout and somewhat flattened toward end, 0.14 mm long. Outer lobe of harpagones with three bladelike filaments subequal in length and broadest near tip, the longest about 0.07 mm; inner lobe with a stout hair at apex, 0.10 mm long, and well separated from this internally a slenderer hair, 0.07 mm long (Plate 2, fig. 6). Mesosome with very many slender leaflets (Plate 2, fig. 4), eighteen or nineteen on each side in three specimens, counted after separating the mesosome from the hypopygium and flattening under a cover glass. Some of the leaflets are serrated along the side and some are split at the tip.

The harpagones of *A. lindesayi* as described by Christophers (1915) have two bladelike spines on the outer lobes, instead of three, and a much smaller number of leaflets on the mesosome—about five as compared to eighteen or so in var. *benguetensis*.

Larva.—The characters recorded for one of the larvæ from the original collection are as follows: Inner anterior clypeal hairs long, simple and close together; outer clypeals simple, less than half the length of the inner; postclypeals about as long and as widely separated as the outer, two branches on one side and three on the other (Plate 1, fig. 2). Inner occipital hairs simple on one side, forked on the other; outer occipitals three and four branched. Inner anterior submedian thoracic hairs (Plate 1, fig. 4) with thirteen and fourteen branches; middle hairs longer, with fourteen and twenty branches. Thoracic palmate tuft developed, the leaflets being slenderer than those on the abdomen (Plate 1, fig. 6); abdominal palmate tufts developed on segments II to VII, the leaflets with filaments (Plate 1, fig. 8). The lateral hairs on abdominal segment IV, three branched, on segment V, three and two branched and absent on segment VI.

From other specimens collected and examined by Mr. Baisas, the postclypeal hairs are sometimes simple, although two or three divisions is the usual number. The antipalmate hairs on segment II have about six branches; on segment III usually five or six; on segments IV and V, single; on segment VI usually three and on segment VII, five.

The larvæ are pigmented and mottled on the dorsal surface of the thorax and abdomen, and wide pigmented bands completely

surround abdominal segments II, IV, VI, VII, and VIII, giving the larvæ a characteristically striped appearance and distinguishing them from other species with which they occur. The banding still appears after preservation in formalin.

Type female reared from larva collected at Baguio, Benguet Subprovince, Luzon, Philippine Islands, May 20, 1931. Taken at an altitude of about 4,700 feet.

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ILLUSTRATIONS

[The illustrations are from camera lucida drawings made by F. E. Baisas and F. del Rosario.]

PLATE 1

FIG. 1. Clypeal hairs of *A. gigas* var. *formosus*.
2. Clypeal hairs of *A. lindesayi* var. *benguetensis*.
3. Anterior submedian thoracic hairs, left side, of var. *formosus*.
4. Anterior submedian thoracic hairs, right side, of var. *benguetensis*.
5. Branched hair in place of thoracic palmate of var. *formosus*.
6. Thoracic palmate of var. *benguetensis*.
7. Two leaflets from an abdominal palmate tuft, segment IV of var. *formosus*.
8. Two leaflets from an abdominal palmate tuft, segment IV of var. *benguetensis*.

PLATE 2

FIG. 1. Wing of var. *formosus*.
2. Wing of var. *benguetensis*.
3. The leaflets from one side of the mesosome of the male genitalia of var. *formosus*.
4. The leaflets from one side of the mesosome of var. *benguetensis*.
5. Half of the harpagones of var. *formosus*.
6. Half of the harpagones of var. *benguetensis*.

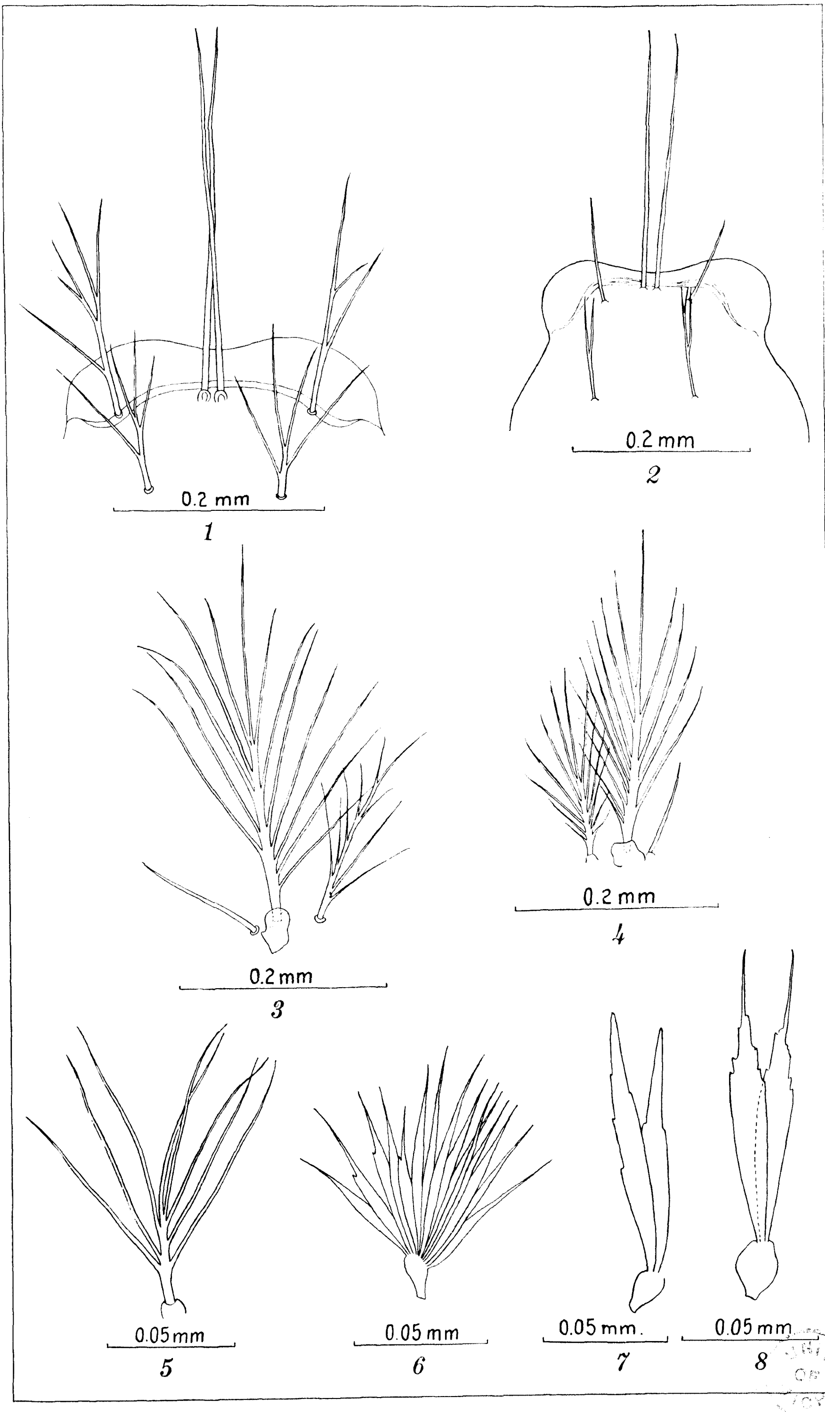

PLATE 1.

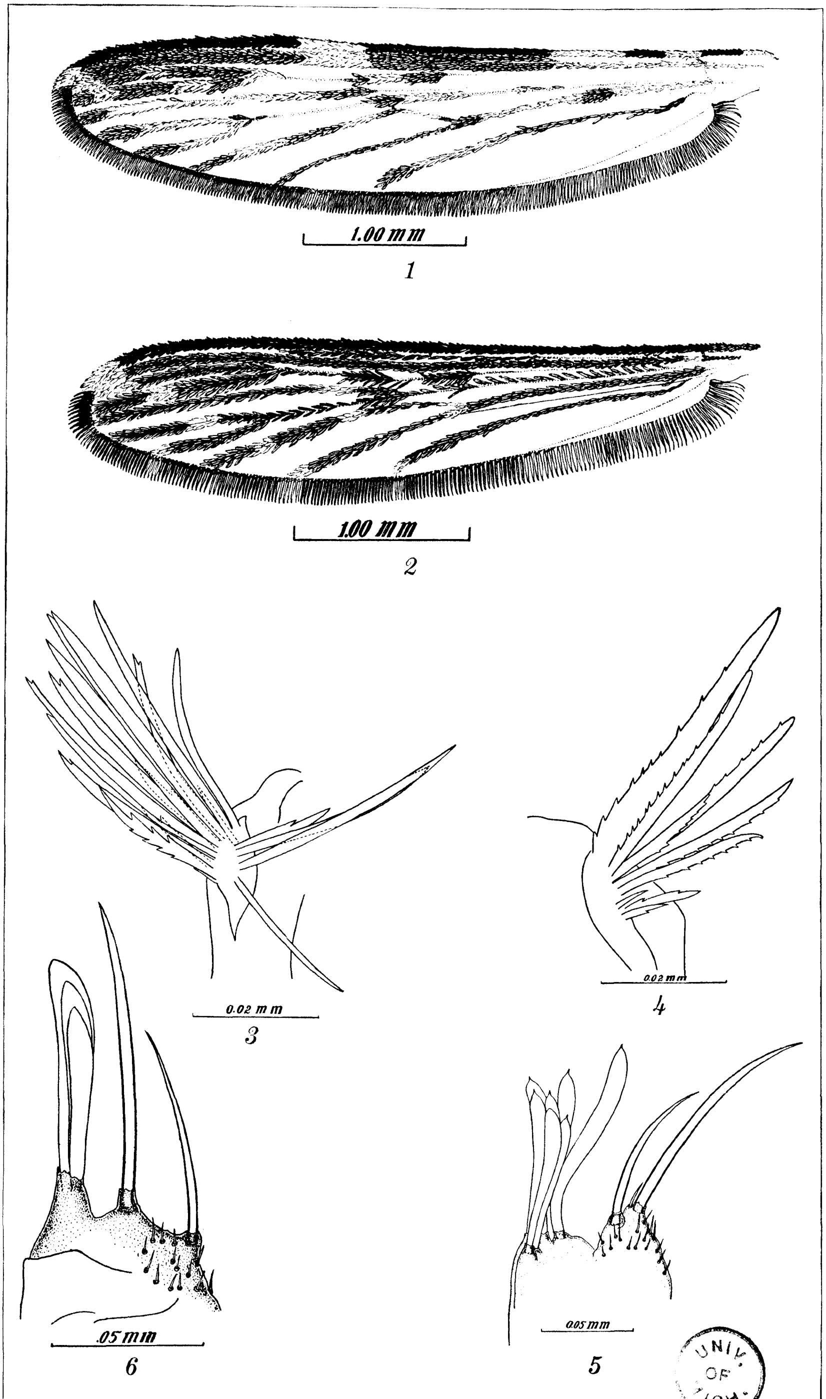

PLATE 2.

THE USE OF THE ANTENNÆ AS A MEANS OF DETERMINING THE SEXES IN LEUCOPHOLIS IRRORATA ADULTS (COLEOPTERA, SCARABÆIDÆ)[1]

By A. W. LOPEZ

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ONE PLATE

INTRODUCTION

The flying season of *Leucopholis irrorata* beetles in Occidental Negros normally occurs during the latter part of April, all of May, and the first part of June.

During the season of 1930, this entomology department examined 1,663 beetles in order to determine the sex ratio and the egg content of beetles collected in the field, for the purpose of securing data on the soundness of the collecting campaign principle. Because neither the writer nor other local entomologists could differentiate between the sexes at sight, it was necessary to dissect every individual in order to determine its sex, with a consequent expenditure of a great amount of time.

At the start of the 1931 season it became apparent to the writer that males could be separated from females through certain characteristics inherent in the antennæ. It is now possible to take a group of beetles on which data are desired, and rapidly and accurately to pick out the males and females. The former may then be counted, and only the females dissected. This differentiation cannot be practiced immediately, but a small amount of practice will enable one to so differentiate rapidly.

MATERIAL AND METHODS

One antenna and the elytron from the same side were removed from a live *L. irrorata* beetle, and the club of the former and the total length of the latter were measured with a stage micrometer to one-tenth of a millimeter. An assistant then dissected the

[1] The most important sugar-cane white grub (buc-an) of the Philippines.

beetle positively to determine its sex. One hundred antennal clubs and elytra were so measured for each sex.

In making the drawings of the extended antennal clubs, some difficulty was encountered because they immediately became compact when the antennæ were severed. Submersion in 80 per cent alcohol or concentrated acetic acid for a short time caused them to extend themselves in approximately the normal manner. The drawings were made with the aid of a camera lucida.

THE DIFFERENTIATION OF THE SEXES

The length of the male antennal club (Plate 1, fig. 2) as deduced from the measurement of one hundred individuals, averages 1.87 millimeters ± 0.0076 millimeter [2] and the female antennal club Plate 1, fig. 1) averages 1.3 millimeters ± 0.0073 millimeter, the male antennal club being approximately 0.57 millimeter longer than that of the female. While the difference is not great it is readily perceptible to the naked eye.

The elytra were measured in order to ascertain whether or not the size of the beetle had an appreciable influence on the length of the antennal club. If the size of the beetle should influence the size of the club, then a female that happened to be larger than a male would have a longer club and the differentiation could not be made. A summary of the results of the measurement of the clubs and of the elytra, which are considered indicators of the size of the beetle, is shown in Table 1.

TABLE 1.—*Showing summary of results of club and elytra measurements in Leucopholis irrorata.*

	Average length in 100 individuals.		Sizes.			
	Elytron.	Antennal club.	Shortest elytron.	Antennal club.	Longest elytron.	Antennal club.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Male	18.3±0.0494	1.87±0.0076	16.5	1.8	19.6	1.9
Female	18.9±0.0615	1.3±0.0073	16.4	1.2	21.0	1.4

In Table 1, the female elytron is shown to be approximately 0.6 millimeter longer than that of the male, while the antennal club is approximately 0.57 millimeter shorter than that of the male, as mentioned above. It may also be noted in the table that the male beetle with the shortest elytron had a club about

[2] Probable error for the mean.

0.07 millimeter shorter than the average, and that the male with the longest elytron had a club about 0.1 millimeter longer than the average. In the females there is only a difference of about 0.1 millimeter in the length of the antennal club either way from the average in the beetle with the shortest and in the one with the longest elytron. It is thus seen that the size of the beetle apparently does not influence the length of the antennal club to any appreciable extent.

In addition to making the differentiation between the sexes by the difference in length of the antennal clubs alone, the difference in the contour between the posterior edges of the male and female extended antennal clubs can also be made use of.

In the female extended antennal club (Plate 1, fig. 3) at point *a*, the posterior edges of the first two lamellæ form nearly a smooth curve with the last funicular segment (Plate 1, fig. 1, *f*), while in the male (Plate 1, fig. 4) at point *a*, the posterior edges of the first two lamellæ do not form a smooth curve with the last funicular segment, but a distinct drop is noticed, giving the male extended club a characteristic appearance different from that of the female extended club.

The males and females of *Lepidiota pruinosa* may be separated in a manner identical with the above.

ILLUSTRATION

[*a*, Reference point; *c*, club; *f*, funicle; *l*, lamellæ; *p*, pedicel; *s*, scape.]

PLATE 1

FIG. 1. Right antenna of female *Leucopholis irrorata*, × 30.
2. Right antenna of male *L. irrorata*, × 30.
3. Extended right antennal club of female *L. irrorata*, × 30.
4. Extended right antennal club of male *L. irrorata*, × 30.

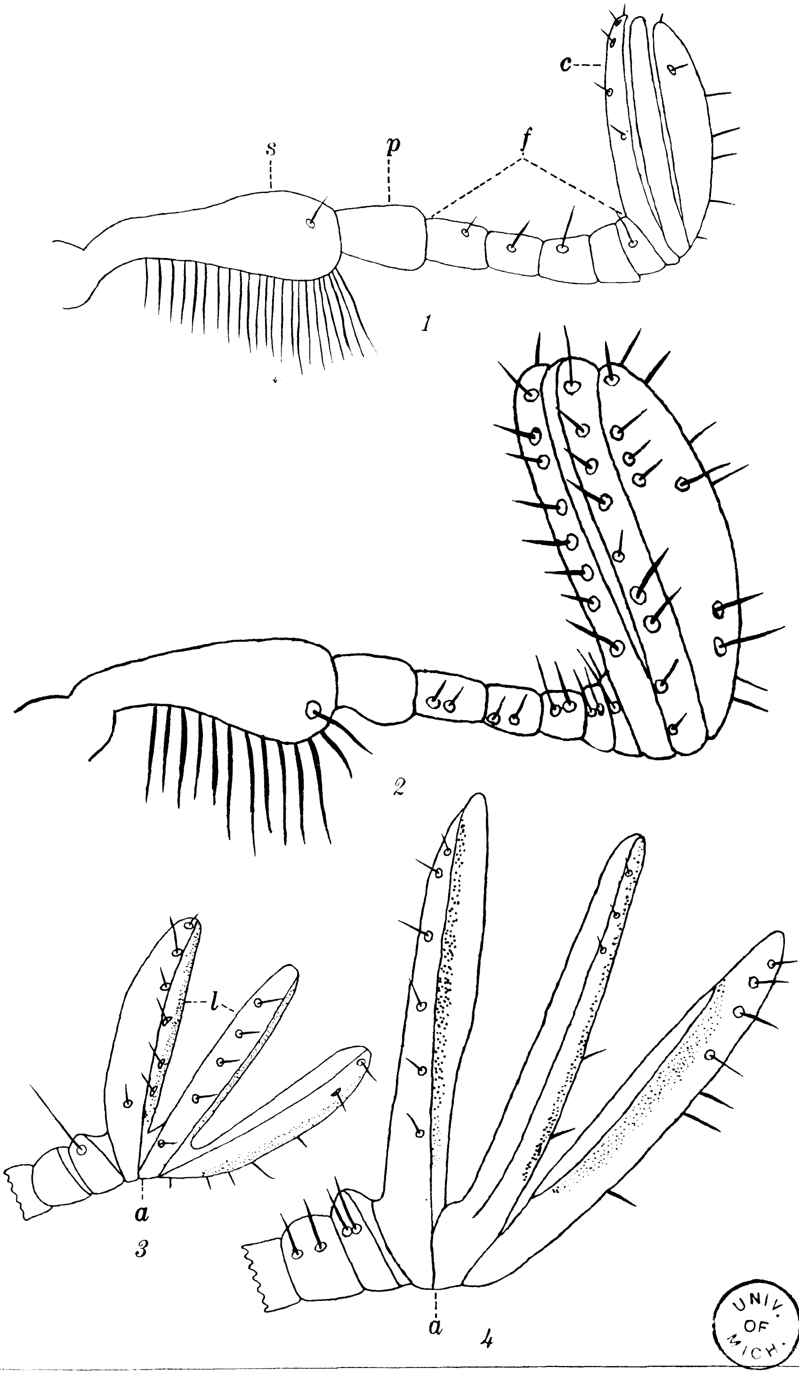

PLATE 1.

INDEX

[New names and new combinations are printed in **boldface.**]

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